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## Construction of Wanaque Aqueduct

Design details and construction methods of aqueduct including more than thirty miles of wrapped steel pipe and two and a half miles of concrete pipe in tunnel, to deliver one hundred million gallons a day to communities in northern New Jersey

By A. A. Jones\*

### GENERAL DESCRIPTION

The Wanaque aqueduct, now being built by the North Jersey District Water Supply Commission, extends from Wanaque dam, at the lower end of Wanaque reservoir in Passaic County, N. J., to Belleville reservoir in the town of Belleville adjoining the city of Newark. The total length of the aqueduct is approximately 20.5 miles. This includes, roughly, 14 miles of twin pipe lines, 4 miles of single pipe line and 2.5 miles of tunnels. The aqueduct is designed for annual average delivery of 100 million gallons per day, to be allocated to the various municipalities which are furnishing funds, under agreement, for its construction as follows:

	M.G.D.
Paterson, Passaic and Clifton .....	37.75
Montclair, Bloomfield and Glen Ridge ..	9.75
Newark .....	40.50
Kearny .....	12.00

\*Executive engineer, Fuller & McClintock, New York City.

Headworks, located at the lower side of the dam, will consist of pumping station, service building, aerator, lower gate house controlling flow to the aqueduct and pumping station, control house for regulation of aerator, and surge tank for balancing pumping head.

Leaving the headworks at the lower gate house, the first 1700 feet of the aqueduct is a single line of 84-inch pipe; the first 200 feet being steel pipe placed in open cut and the balance being Lock Joint concrete pipe placed inside Wanaque tunnel. At the lower end of the tunnel a Y chamber divides the aqueduct into twin steel lines of Lock-bar pipe 74 inches in diameter. These twin lines extend for a distance of about 14 miles to the northerly approach of Great Notch tunnel, where another Y chamber unites the two into a single line carrying into the tunnel. From the southerly approach of Great Notch tunnel a single line of 74-inch Lock-bar pipe runs for a distance of nearly four miles to the lower terminus of the aqueduct at Belleville reservoir. Of the 164,150 feet of

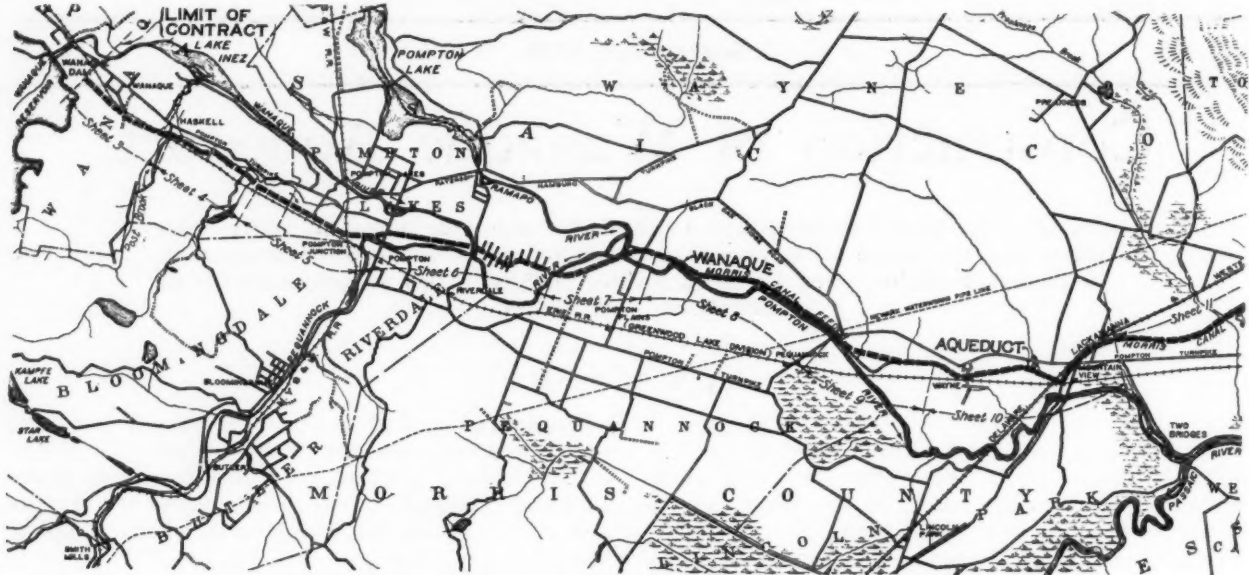


CARRYING LINES OF 74-INCH STEEL PIPE UNDER RAILROAD AT STA. 53.

74-inch Lock-bar pipe, 2200 feet, located at the lowest point of the aqueduct, is of  $\frac{1}{2}$ -inch plate, and the balance is of  $\frac{7}{16}$ -inch plate.

At a point near Pompton Plains, the twin lines enter the upper end of the abandoned Morris Canal

In addition to 35,000 tons of steel pipe, some of the larger items of the contract for the pipe lines include 375,000 cubic yards of earth and 10,000 cubic yards of rock excavation, 100,000 cubic yards of borrow, 350,000 cubic yards of refill and embankment

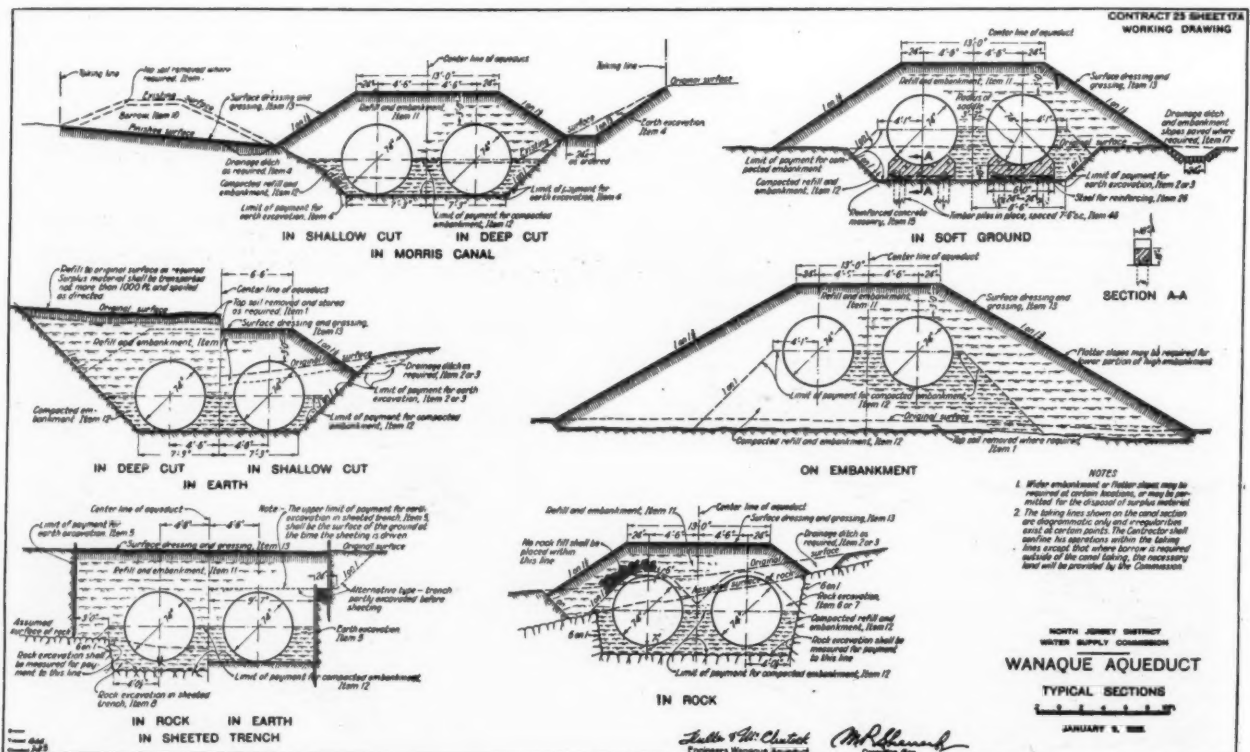


MAP SHOWING LOCATION OF NORTHERN PART OF AQUEDUCT

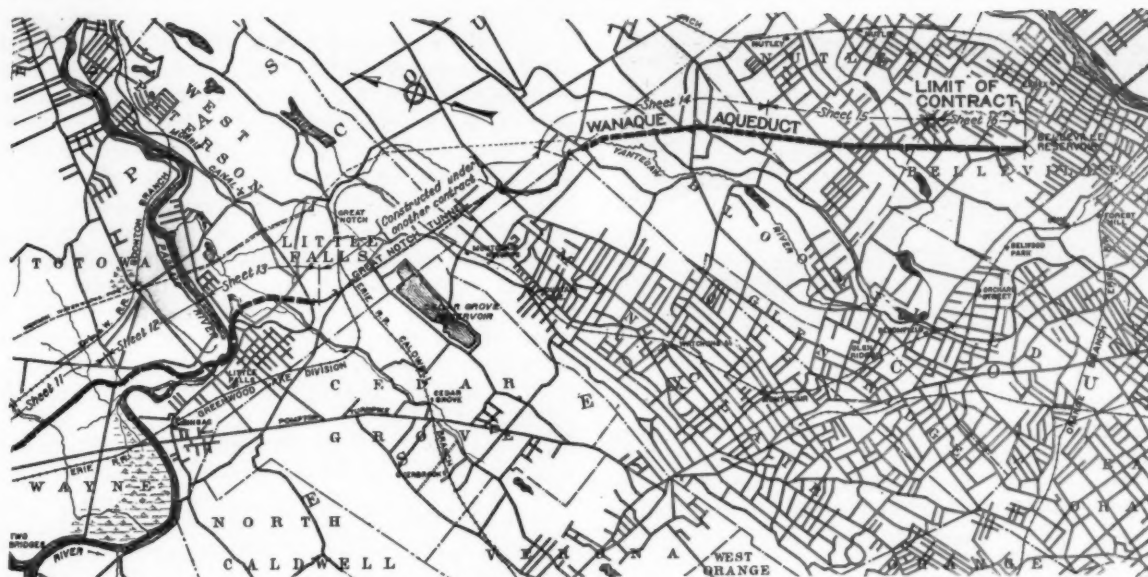
feeder and follow the feeder and canal to Little Falls, a distance of  $7\frac{1}{2}$  miles. Practically the entire four miles of single line below Great Notch tunnel is located in a 99-foot strip of land comprising the right of way occupied by the 51-inch steel pipe line of the Passaic Consolidated Water Company and the 42-inch and 48-inch steel pipe lines of the city of Newark.

and 80,000 cubic yards of compacted refill and embankment, 200 tons of steel pipe specials, thirty-six 48-inch gate valves and 370 smaller valves ranging in size from 4-inch to 12-inch.

The greater part of the construction work is a cut and cover job, with some special work required at stream crossings where the steel pipes are encased in concrete. Twin lines are spaced 9 feet on centers re-



TYPICAL SECTIONS OF WANAQUE AQUEDUCT



MAP SHOWING LOCATION OF SOUTHERN PART OF AQUEDUCT

quiring a trench 16 feet wide at the bottom. For the single line a trench  $5\frac{1}{2}$  feet wide is required. That portion of the line located in the beds of the abandoned Morris canal and feeder requires only a shallow cut. A minimum of 3 feet of fill over the top of pipe is specified in all cases.

Cross connection between the twin lines is effected in five cross-connection chambers, spaced approximately at equal distances, as well as in the Y chambers at the upper and lower ends of the twin lines portion. In each chamber a group of five 48-inch valves arranged in the form of an H, two in each main and one in the connecting leg, permits bypassing of water in either direction so that a section of pipe between any two chambers may be closed off and emptied for repairs.

Drainage manholes are provided at low points in the line; air valves are located at summits. Air valves are of two types; 6-inch and 4-inch vacuum valves, arranged in groups of from one to eight, permit the entrance of air automatically into the pipes and safeguard them against collapse in case of a break. Pressure air valves automatically release accumulated air but prevent the escape of water.

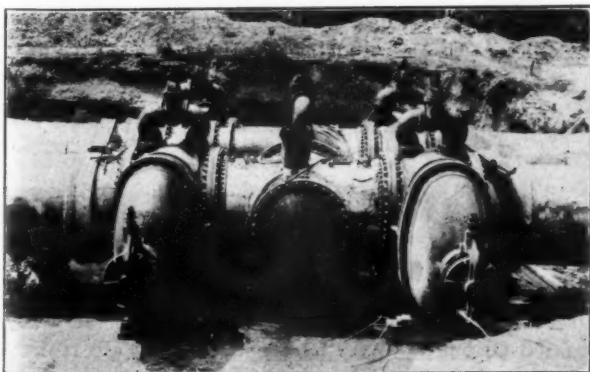
In establishing the diameter of pipes required, appropriate differentials were set up for different types of pipe, taking into account smoothness and frequency of joints. Bids were taken on the following types of steel pipe:

- 74-inch lock-bar, 30 foot courses
- 74-inch hammer-welded, 30 foot courses
- 74-inch countersunk-riveted, 30 foot courses
- 74-inch countersunk-riveted, butt-girth joints,  $7\frac{1}{2}$  foot courses
- 76-inch countersunk-riveted  $7\frac{1}{2}$  foot courses
- 75-inch button-head riveted, 30 foot courses
- 78-inch button-head riveted,  $7\frac{1}{2}$  foot courses

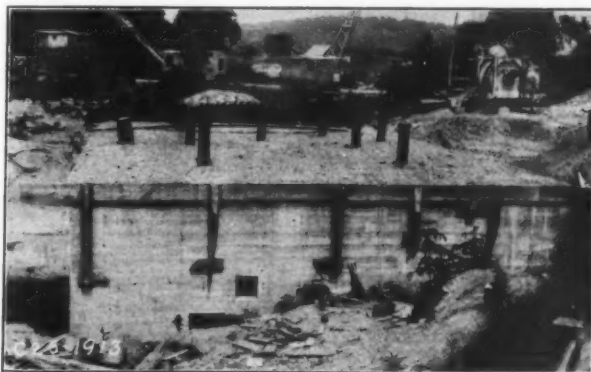
Bids were taken on December 20, 1928, the successful bidder being T. A. Gillespie Co., of New York, and the contract price \$5,127,628. The contractor's price on lock-bar pipe, 74"x7/16", was \$24.75 per lineal foot. The next highest bidder gave a price of \$23.40 per foot, on 74"x7/16" countersunk-riveted pipe in 30 foot courses. This bidder's prices on grading and other items of the contract brought his total some \$600,000 higher than the lowest. No other bids were received on this type of pipe. Six bids were received on 76"x7/16" countersunk-riveted pipe in  $7\frac{1}{2}$  foot courses. The prices in these bids ranged from \$25.60 to \$33.60 per foot. In all, ten bids were received, the highest running to \$7,718,406.

#### SPECIAL FEATURES

*Pipe Wrapping.*—Among the interesting features of this work is the pipe wrapping which, heretofore, has not been extensively used in this part of the country. The wrapping being used is "Pabco," made by the Paraffine Companies, Inc., of San Francisco; coating is "Ovarco," made by the Ohio Varnish Co.,



VALVES IN PLACE FOR CONNECTION CHAMBER



VIEW OF COMPLETED CONNECTION CHAMBER



CONCRETE BUTTRESSES TO PREVENT SHIFTING OF PIPE LINE WHEN UNDER PRESSURE

Cleveland. "Pabco" is a felt material which has been thoroughly saturated with a high melting point bituminous compound. Flaked mica is applied to the outer side in sufficient quantity to afford satisfactory protection, the finished product weighing approximately 3.6 pounds per square yard. Its adoption in this instance was due to a number of considerations, to wit: First, it is believed that the wrapping will afford considerable added protection against humic acids found in swampy ground; second, the wrapping prevents all but a small portion of the damage to the coating ordinarily resulting from abrasion due to handling and shipping, and weathering while stored along the site of the work; third, independently of the felt proper, more than ordinary protection is obtained from the hot dip coating, by reason of the fact that the dip used in cementing the wrapping to the pipe adds as much coating again as is applied in the dipping bath.

Shop practice in applying coating is to dip each 30-foot section of pipe after heating to 350 degrees F. After the pipe has cooled sufficiently to be handled, it is placed in a lathe type machine by which it is rotated and the wrapping is applied spirally while hot dip is poured in, forming a complete seal of the wrapping to the pipe. A tension of about 50 pounds is applied to the 18-inch width of wrapping while it is being wound about the pipe. The entire length of the 30-foot section, with the exception of a 6-inch band at each end left uncovered for field joints, is covered at one operation.

Field practice in covering joints is to clean and cover the exposed section of pipe with bituminous paint immediately after the joint is riveted and caulked. After the pipe has received the prescribed test for leakage, and any leak re-caulked, wrapping

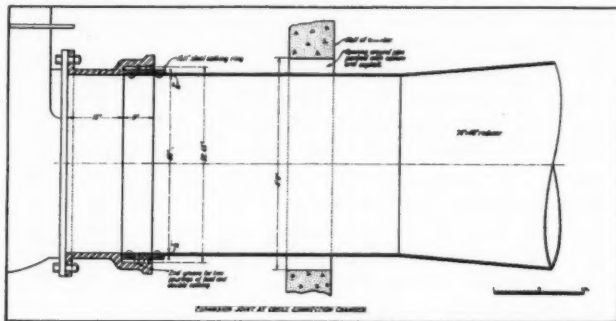


BUCKING UP RIVET CHAIN FOR FURNISHING LEVERAGE TO DOLLY BAR. SHOWS UNWRAPPED ENDS OF PIPES

is applied to the field joints. The joint hole in the trench is pumped out to allow free access to the entire periphery of the joint. The joint is cleaned and painted with bituminous paint and the wrap applied in strips about 6 feet long and 18 inches wide. These strips also are coated with dip on the side coming in contact with previously painted metal. Each strip is worked back and forth until it is in close adhesion to the pipe. Lapping strips are then similarly applied, with at least a 12-inch lap. When the joint is completely covered it is secured with cords around the pipe, and at the contact of old and new wrapping more dip is applied.

In general it has been found that the wrapping has afforded excellent protection to the pipe. In very few instances, except in major accidents, has there been sufficient abrasion due to shipping and handling to uncover the metal and expose it to corrosion.

*Expansion Joints.*—No expansion joints are provided except in cross-connection chambers. A 74"x48" reducer is placed in each line on each side of the chamber, the diameter of pipe passing through the wall of the chamber being 48 inches. A steel caulking ring 1 inch by 11 inches attached to this length of pipe with countersunk rivets enters the bell of a cast-steel bell-and-flanged piece, which is in turn bolted to



EXPANSION JOINT AT CROSS CONNECTION CHAMBER

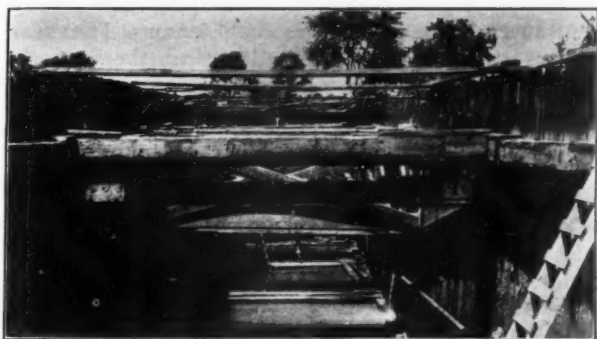
the 48-inch gate valve. The bell of this connecting piece is 9 inches in depth and has two caulking grooves, thus providing for two pourings of lead and double caulking. The caulking ring on the end of the steel pipe, being smooth, is free to come and go, and the 48-inch steel pipe passes through the wall of the chamber in an opening 4 feet 9 inches in diameter, the opening around the pipe being packed with oakum and asphalt.

*Stream Crossings.*—Eleven stream crossings of major importance are encountered in the length of the aqueduct. Watersheds of these streams vary from one square mile for the smallest to 775 square miles for the Passaic river, which is crossed at Little Falls. At each of these crossings the pipe is encased in a concrete envelope. Under the contract these eleven crossings are listed under a separate item with specifications covering the additional work incurred in the way of cofferdams, stream control, pumping, etc., which are paid for in a lump sum. Excavation, pipe, concrete in envelopes, etc., are paid for under unit prices.

Three major stream crossings have been laid to date. At the Wanaque river the entire stream was bypassed through a parallel trench dug in a natural high water channel, thus permitting the work of pipe laying and concreting to be carried on between paral-



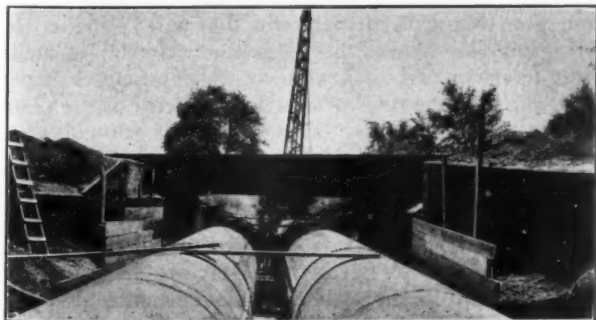
PILING IN PLACE FOR HALF OF POMPTON RIVER CROSSING



INSIDE OF COFFER DAM, POMPTON RIVER CROSSING

lel lines of steel sheet piling placed by a stiff-leg derrick with a 100-foot boom, extending across the entire width of the river. At the Pompton and Pequannock rivers, work was carried on within cofferdams of steel sheet piling. At the Pompton river a cofferdam enclosing about two-thirds of the crossing was placed by a 100-foot boom derrick, similarly to the Wanaque crossing. A second cofferdam, enclosing the balance of the crossing, was driven by means of a gasoline-driven crawler crane on a temporary pile trestle extending out about 30 feet from the shore alongside the crossing. At the Pequannock river a temporary pile trestle was first built alongside the crossing spanning the entire width of the stream. A steam-driven locomotive crane was used for both operations of driving piles for the temporary trestle and driving the steel sheet piling from the trestle after its completion. At this crossing also, two cofferdams were built, each enclosing about one half the crossing, in which pipe was laid and the concrete envelope poured.

**Railroad Crossing.**—The Greenwood Lake Division of the Erie Railroad is crossed at Haskell and the N. Y. S. & W. at Pompton Junction. At each of these points an undercrossing has been constructed consisting of a flat, reinforced concrete slab supported by



UNDERPASS AT D. L. & W. RAILROAD

reinforced concrete abutments. At Haskell, where the crossing is at an angle of about 50 degrees, distance between pipe centers of the twin lines was increased to 11 feet 3 inches and a pier placed between the pipes. At each crossing a temporary bridge carrying the track was built prior to beginning excavation. At the Haskell crossing three double 7-pile bent piers were placed to support I-beam girders carrying the track over the central part of the excavation, with the center temporary pier off center to permit construction of the center permanent pier. Excavation under the track was sloped 1-1/2 to 1 and the track over the sloped portion was carried on 4 pile bents with three 8-inch by 16-inch stringers under each rail. Middle spans were 26 feet 9 inches and 15 feet respectively and outer spans 12 feet. After excavation was completed the northern half of the permanent structure was poured. After the concrete had set the center temporary pier was removed and the track supported on the concrete. The southern half of the permanent structure was then poured, excavation refilled and track restored to its original condition. At the Pompton Junction crossing, a similar method was followed except that, this crossing being at 90 degrees, it was unnecessary to increase the distance between pipe centers and the whole structure was built in one operation. The central span of the temporary structure, formed of I-beam girders, was 28 feet 6 inches and the outer spans 12 feet.

At Mountain View, where the aqueduct is in the Morris Canal bed, there is an undercrossing of the D. L. & W. R. R. At this point the track is carried on steel girders supported by concrete abutments. The twin pipes have been laid directly through the existing structure which is filled in with concrete to a depth of 12 inches over the tops of the pipes.

*(To be concluded)*

## Trade Waste Problem in New Jersey

**State departments should be authorized to investigate methods of treating wastes. No accepted methods available. Nearly half the organic pollution of one river due to wastes**

The problem furnished by the discharge of trade wastes into streams in the state of New Jersey was a subject of discussion at the last annual meeting of the New Jersey Public Health & Sanitary Association. The subject was treated from the legal and administrative point of view by H. P. Croft, chief engineer of the New Jersey State Department of Health; and from the technical point of view by Willem Rudolfs, chief of the Department of Water Supply & Sewage Disposal of the New Jersey Agricultural Experiment Station.

Mr. Croft stated that the public health laws of New Jersey which relate to the pollution of waters differentiate between waters used for public potable purposes and the harvesting of shellfish, and those used for all other purposes. There is state legislation empowering the State Health Department to "investigate the various methods of sewage disposal, in order to make

proper recommendations in regard thereto," but no such legislation empowering it to make similar investigations with regard to industrial wastes.

During the past few years, representatives of the State Health Department have investigated complaints of stream pollution and have found that most of them were due to "discharge of wastes from laundries, creameries, industrial plants engaged in the canning of vegetables and fruits, in the manufacture of dyes and in dye printing work, in the reclaiming of rubber and manufacture of rubber products, in the manufacture of millboard, paper, certain chemical preparations, vegetable oils, and starch. Every year shows an increase in the number of complaints." With few exceptions, the polluters have shown a willingness to cooperate with the Department in the abatement of such pollution if the Department would make proper recommendations; but suggestions could be given for treating only a few of the wastes mentioned, because investigations and research in the field of industrial waste disposal have been limited, both legally and financially.

A bill was introduced in the 1928 legislature, the purpose of which was to authorize the Agricultural Experiment Station and the Department of Health to investigate waste treatment, but was not passed.

In discussing the subject from an engineering and technical point of view, Dr. Rudolfs stated that, according to the 1927 Industrial Directory of New Jersey, about two billion dollars capital was invested in industries producing products with a total value of more than one billion dollars. Wastes are discharged by about 700 industries exclusive of dairies and laundries, part of which are wholly or partially treated before being discharged into the rivers and bodies of water. An extensive survey of the Raritan river and its tributaries showed that the population of this valley is about 100,000, practically all discharging raw sewage into the river system, while the organic pollution caused by the industries is equivalent to the sewage from a population of 80,000 persons; indicating that more than 40% of the total organic pollution of the Raritan is caused by its industries. In addition to this organic pollution, considerable amounts of chemicals, consisting of acids, alkalis, dyes, poisons, etc., are discharged. In some instances, the industrial wastes constitute a much greater factor in the problem of stream pollution than does domestic sewage.

"There are two ways of treating the industrial wastes before discharge: (1) allowing the industrial waste to be led into the town's sewers, and treating the mixture in a disposal plant; and (2) treating the industrial waste at or near its source."

The former is frequently objectionable because the nature of the waste may be such as to cause great trouble at the sewage treatment plant, and also because the large amounts of waste often equal in volume or more than equal the total volume of the town's sewage. Numerous examples could be cited where milk, laundry, wool, and silk wastes, dye wastes, acid and alkali wastes upset the disposal system, causing nuisances and additional expense. It is questionable whether the taxpayers should shoulder the burden of the cost of building greatly enlarged sewage treatment plants and pay the cost of operation of such plants, because of trade wastes in the sewage. On the other hand, although treatment of the industrial

waste by the industries might be possible in a number of instances without putting undue burden upon the industries, it should not be forgotten that the industries in New Jersey often must compete with industries in other states which are not obliged to treat their wastes.

Dr. Rudolfs stated that the problem could be divided into two phases: "(1) utilization of the wastes within the industry, and (2) treatment of the residual waste after as complete utilization as possible . . . Canning waste treatment is especially a difficult problem, since canning is seasonal. The pea, tomato, bean and other canneries are often located in rural districts, causing nuisances and polluting the small streams. The creamery waste problem involves large numbers of milk producers and the problem is becoming more and more pressing."

"There has been some study in regard to the treatment of certain industrial wastes, but in no instance has an accepted method been developed for any particular waste. There has been as much work done in the country on the treatment of milk products and tannery wastes as of any other type, but no uniformly satisfactory method has as yet been developed. The paper industry can probably economically reduce fiber losses to such an extent that pollution from this source will not be objectionable, but no economical methods of utilizing other types of waste from this industry have as yet been developed. Methods of recovery and treatment of the waste of dye establishments are practically unknown; treatment of laundry wastes is still unsolved; wastes from metal products, apparently one of the simplest to be treated, are nearly all discharged without treatment; wastes from silk and woolen industries, causing great nuisance and placing a heavy burden upon the streams, await methods of treatment. More and more of the wastes from tanneries is recovered, but no efficient method is available to treat the residual waste. It would be possible to extend this list almost indefinitely, yet there are excellent examples where industries, due to pressure to improve stream conditions, have developed recovery processes that have either eliminated or materially reduced the effect of their wastes upon the streams. In many instances, this recovery of waste has resulted in substantial financial return to the industry itself. One of the most outstanding examples in this respect is that of the Corn Products plant at Argo, near Chicago. Originally the waste from this industry was equivalent to the domestic sewage from some 370,000 people, and it would have cost \$3,000,000 to install a plant to treat it in the manner of sewage purification. Research, resulting in recovery processes, has reduced this to an equivalent of about 50,000 people, and probably still further reduction will be made. In bringing this about, the recovered material is made into food for livestock at a value of about \$30 per ton, which on the total production capacity of the plant amounts to a financial saving of about \$500,000 annually. Several other examples could be cited, not so spectacular, but of economic value.

"Although the state should be in a position to lead and direct investigations and conduct small experiments in order to develop satisfactory methods, the major cost of plant scale experimentation and development of practical treatment processes should be borne by the industries."

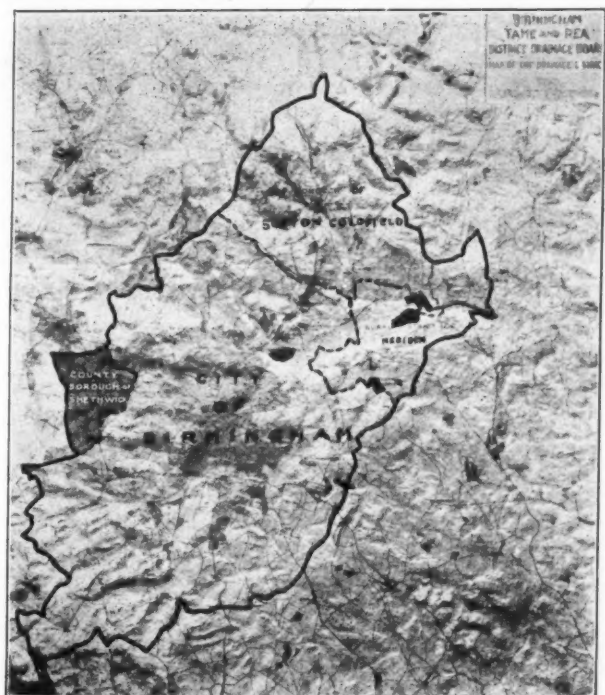
# Sewage Treatment at Birmingham, England

Description of one of the notable English plants, which uses sedimentation tanks and bacteria beds, and activated sludge for a part, and utilizes the gases of decomposition to operate and light the plant

American sanitary engineers obtained their first ideas of sewage treatment methods from England and continue to follow carefully all developments in this branch of engineering reported from that country. Among the most interesting of the English plants for several years past has been that conducted by the Birmingham Drainage Board for treating the sewage from the Birmingham, Tame and Rea District. From time to time, PUBLIC WORKS has published information concerning recent developments and experiences at this plant. It has been some years, however, since we have given a full description of the plant, and it seems worth while to describe its present status since the changes made about 1924.

This drainage district has an estimated population of about 1,100,000 persons, of which about 1,000,000 are in the city of Birmingham, 77,000 in the County Borough of Smethwick, and the balance in Sutton Coldfield, part of the urban district of Perry Barr and part of the rural district of Meriden.

To purify the sewage from this population, the board has three works, the main one being in the Tame Valley, and including interdependent works at Saltley, Ashold, Tyburn and Minworth. This plant deals with a dry weather flow of 29,000,000 gallons per day, while two works in Cole Valley, at Cole Hall and Acock's Green, treat a dry weather flow of 3,000,000 gallons per day. The more than 1,000 miles of subsidiary sewers in the district converge toward three large arteries which serve these three plants.



MAP OF BIRMINGHAM TAME AND REA DRAINAGE DISTRICT

The sewages delivered by these sewers differ from each other in both chemical analysis and in appearance, and also change considerably from day to day, the impurity as measured by oxygen absorbed figures varying from 100 parts a million one day to as high as 330 parts the next. The rate of flow of this sewage also varies from hour to hour during the day, as shown by the accompanying typical diagram.

Like most English systems, these sewers are on the combined plan, and during time of storms the rate of flow reaching the treatment works may increase to 300,000,000 gallons per day.

All these sewages are alkaline in reaction and are strongly colloidal. An average of the sewage analyses for two years, in parts per million, is as follows: Suspended solids, 435; free ammonia, 41.1; albumenoid ammonia, 13.4; chlorine, 151; oxygen absorbed in four hours, unsettled, 185.4, settled, 144.3; alkalinity, 238.

The heavy suspended matter is removed from the sewage at Saltley by discharging the sewage into a long V-shaped detritus pit, from which it is removed continuously by means of a traveling dredge, which loads the grit, stones and sand into wagons, which dump it on adjoining land where it dries rapidly into an innocuous condition. It is of little value for fertilizing purposes.

The sewage then passes through sedimentation tanks with a capacity of 11,500,000 gallons (throughout this article the English gallon is used, which is about 20% larger than the American gallon), in which the velocity is about 90 feet per hour. These are horizontal-flow sedimentation tanks, and are divided into two sets known as primary and secondary. In the secondary tanks, the sewage is impounded during the period of greatest flow, and they discharge their effluents at a constant rate during the entire twenty-four hours. Their combined effluent flows through 4½ miles of 8-foot sewer to Minworth for

BIRMINGHAM DRAINAGE BOARD  
AVERAGE HOURLY VARIATION IN RATE OF FLOW OF SEWAGE

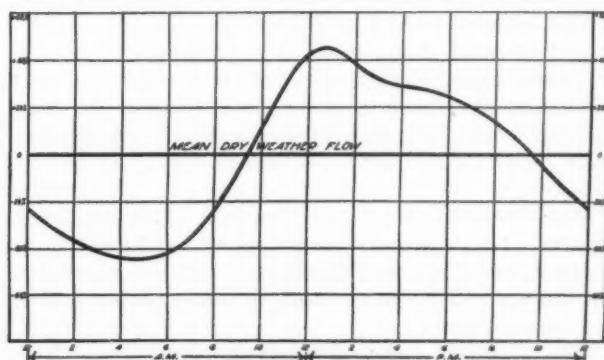
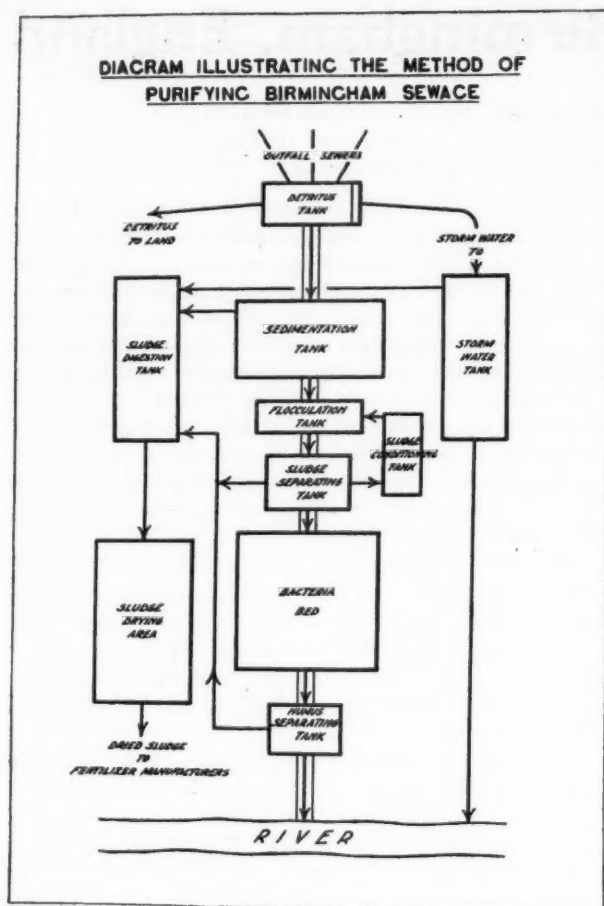


DIAGRAM SHOWING VARIATION IN RATES OF FLOW OF SEWAGE AT BIRMINGHAM



further treatment; the effect of storage in the secondary tanks being that it reaches that plant not only at a uniform rate, but also much more thoroughly mixed and with a more uniform character.

Not less than 75% of the settling suspended matter is deposited in the sedimentation tanks, from which it is removed by means of sludge pumps, which clean the tanks in rotation as frequently as possible in order to prevent fermentation of the sludge.

The storm flow through the tanks is limited to three times the average dry weather flow, the excess between 3 and 6 times being deflected by means of storm overflow weirs into a separate system of storm water tanks. All storm flow above six times the dry weather flow is discharged untreated into the river. The storm water tanks are kept empty during dry weather.

The effluent from the Saltley sedimentation tanks is carried by an 8-foot conduit down the north side of the Tame valley to Minworth, where are situated bacteria beds (percolating filters); receiving on its way tank effluents totaling about 3,000,000 gallons per day from upward-flow tanks at Cole Valley and Sutton Coldfield.

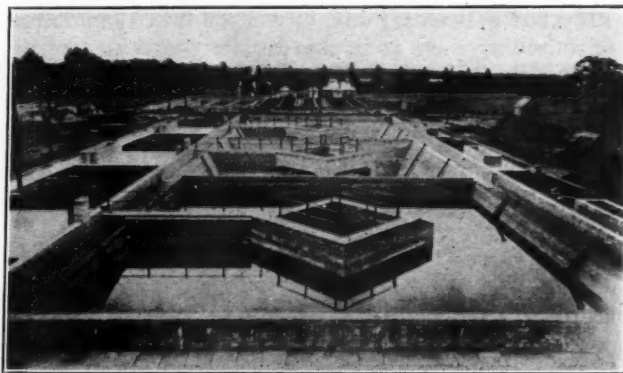
At Minworth the greater part of this combined effluent passes through silt tanks and then direct to bacteria beds; while a small part receives treatment by the activated sludge method before passing onto the bacteria beds.

The principal reason for locating the bacteria beds  $4\frac{1}{2}$  miles from the sedimentation tanks is that at Saltley there is a fall of only a few feet between the

sedimentation tanks and the river; while by carrying the effluent down the valley in a large sewer laid to a flat grade, there is a gain of about 25 feet in relative elevation of sewage and river, and this obviates the necessity of pumping.

During the flow from Saltley to Minworth there are some changes in the effluent, one being that much of the matter which left Saltley in a colloidal state appears at Minworth as flocculent matter. For this reason the effluent is passed through sedimentation tanks at Minworth before being sprayed onto the bacteria beds. The sedimentation tanks at Minworth are of the upward-flow type, pyramidal in shape at the bottom, with vertical walls near the surface; the sewage entering by a pipe which discharges in the middle of the tank, spreads laterally and passes upward through that part with vertical walls at the normal velocity of 7 feet per hour. The sludge is discharged from these tanks daily by hydrostatic head.

As before mentioned, about a quarter of the total flow reaching Minworth is treated by the activated sludge process, which increases the efficiency of the bacteria beds and eliminates the nuisance from odors. The sludge is reconditioned by continuously mixing and aerating it by means either of diffused air or of mixing by aerating machines. The effluent from the activated sludge treatment does not give rise to offensive odors on the bacteria beds, and it eliminates the psychoda, which are a local nuisance at certain times of the year. This effluent is applied to the beds at an average rate up to 1,500,000 gallons per acre without causing clogging, and will cleanse a bed which already has been clogged with sludge through over work.



SEDIMENTATION TANKS, ACTIVATED SLUDGE PLANT

"As compared with methods of using activated sludge for complete treatment of sedimented sewage, the Birmingham method which utilizes activated sludge treatment as an auxiliary to final treatment in bacteria beds, possesses the great advantage of minimizing the inhibiting effect of trade wastes. For example, normal additions of trade waste may cause the Birmingham sewage to vary in strength during the day from 10 parts to 33 parts per hundred thousand (as measured by oxygen absorbed from acid permanganate in four hours at  $29^{\circ}\text{C}$ )."

The bacteria beds (or trickling filters) have a total area of 52 acres, over  $7\frac{1}{2}$  of which the effluent is distributed mechanically, while on the remaining  $44\frac{1}{2}$  acres it is distributed by fixed jets. The filtering medium consists of hard stone or slag, broken to pass

through a 2-inch ring and to be rejected by a 1-inch ring. The effluent from these tanks is stable and non-putrescible. During the low temperature of winter, however, there is a general decline in the efficiency of purification, and accumulation of sludge near the surface of the beds. Through the action of *achorutes viaticus* in the spring, the beds receive an annual cleaning which removes the accumulation of the winter deposits.

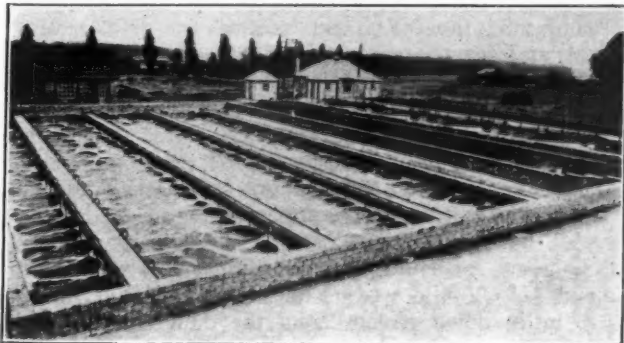
The effluent from these beds is passed through upward-flow humus tanks, similar in construction to the sedimentation tanks previously described. The sludge from these tanks is pumped to sludge digestion tanks.

Although the Royal Commission on sewage disposal recommended that storm water tanks be provided giving a capacity to store one-fourth of the daily dry-weather flow, such tanks are provided at Saltley for storing three-fourths of the dry-weather flow; this seeming desirable because the paving of streets during recent years has resulted in the storm water reaching the sewers so quickly that the discharge from them reaches the rivers Tame and Rea before they have been swollen by the land drainage.

"One of the principal contributing factors of river pollution is storm water discharges, and the efficiency of these tanks as a means of preventing pollution is realized by the fact that over 25% of the total amount of sludge received at the works is arrested by the storm water tanks."

The sludge from the sedimentation tanks is treated in sludge digestion tanks. When sludge is to be removed from a sedimentation tank, this tank is shut down and the water overlying the sludge is pumped away, leaving in the bottom from 2000 to 3000 cubic yards of sludge containing about 90% water. Space in the digestion tanks for this sludge is then obtained by pumping away from the selected tank or tanks about one-fourth of their contents, replacing it with the sedimentation tank sludge.

If the temperature at this time is below 10°C, ripe sludge from one of the digestion tanks is drawn by a pump and discharged into the delivery main which carries the crude sludge, so that a mixture of about one part of ripe material to four of crude sludge is discharged into the digestion tank. In exceptionally cold weather, the temperature of the sludge is raised by injecting steam into the delivery main. The interval between successive charges of crude sludge into a digestive tank varies within wide limits, and may be several weeks. After a digestion tank has received a fresh charge, vigorous fermenta-



SLUDGE RECONDITIONING TANKS

tion sets in after a few days, usually accompanied by evolution of gaseous products of fermentation. It requires about two years for a primary digestion tank to mature to its maximum activity.

The sludge drawn from the primary digestion tanks usually contains much colloidal and imperfectly digested material, and in order to obtain material more uniform and suitable for drying on sludge beds, sludge from the primary digestion tanks is pumped over into secondary digestion tanks. The time of sojourn in the primary tanks is about three months and in the secondary tank about two months.

During digestion, about one-third of the solid matter (on a dry basis) is converted into liquid and gaseous products. Most of the fermentation and evolution of gas takes place during the first three months, while during the remaining time the change is largely one of alteration of physical character of the material, converting it to the condition of a non-reversible colloid in which the sludge will part with its aqueous content fairly readily, when pumped on to drying beds. The crude sludge from the sedimentation tanks has a p H value of about 5.5, while that of the digested sludge is much higher, sometimes as high as 8.5. On the average, the sludge entering the primary digestion tanks has a water content of 91.75%; this has been reduced to 90.52% when leaving the primary tank, and to 88.73% when leaving the secondary digestion tanks. The sludge from the drying beds has an average water content of 35%.

The average of the analyses of gases evolved during the process of digestion is: Methane, 67%; carbon dioxide, 30%; nitrogen, 3%. The calorific value of the mixed gases is 625 B.t.u. It is estimated that



REINFORCED CONCRETE GAS CONTAINERS AT SALTLEY. SCUM IN FOREGROUND AND AT LEFT.

the yield of gas from the primary digestion tanks at Saltley amounts to 150,000,000 cubic feet a year, of which only 16,000,000 cubic feet was being utilized for power purposes at the time of the 1928 report. These gases are used for operating gas engines aggregating 580 h.p., which drive electric generators for supplying power and light to the plant. Reinforced concrete gas collectors weighing 80 tons each, 20 feet long and 10 feet wide, float upon the digesting sludge, which is 14 feet deep. The gas is collected at a pressure of 18 inches water gauge, and stored in the collectors to meet the demand. Incandescent gas lamps lighted by this means demonstrate its suitability for outside lighting.

The sludge from the secondary digestion tanks is pumped on to a drying area at Minworth of approximately 66 acres, under-drained and covered with a

layer of fine ashes from one foot to 3 feet thick. About 6000 tons of the air-dried sludge is sold per year for base for fertilizer, while the remainder, about 24,000 tons per year, is used for filling in low lands.

The small plant at Cole Hall treats the sewage from a population of about 100,000 with a dry-weather flow of about 2,750,000 gallons per day, by means of six detritus tanks, with a total capacity of 100,000 gallons; nine settling tanks, with a total capacity of 2,000,000 gallons, and three storm water tanks with a total capacity of 1,500,000 gallons. There are nineteen rectangular trickling filters of  $5\frac{1}{2}$  acres area and four circular filters with an aggregate area of half an acre. There are also two humus tanks with a total capacity of 500,000 gallons. The effluent is discharged into the River Cole, which is still called a fishing stream and is much purer than the River Tame, and great care therefore is taken to produce an effluent of a high standard by providing a large area of bacteria beds and causing the filter effluent to flow through beds of grass before entering the stream in order to remove all suspended matter.

The Acock's Green plant treats about 300,000 gallons per day from about 12,000 population, and consists of two detritus tanks of about 6000 gallons total capacity, five settling tanks of 125,000 gallons

total capacity, a storm water tank of 200,000 gallons capacity, and  $2\frac{1}{2}$  acres of land available for sludge disposal. The bacteria bed is located on a level piece of ground of  $1\frac{1}{2}$  acres, drained by means of ordinary land tiles laid about 6 feet apart, over which ashes were dumped, with little regard to size, to an average depth of 7 feet. The sewage is distributed over the surface by means of iron pipes spaced about 6 feet apart, from which the liquid emerges through open orifices at  $4\frac{1}{2}$  feet intervals along the pipe. It is expected that this plant will be replaced within ten or fifteen years by a new one at a different site more remote from a residential district.

The area around the Minworth plant is sparsely populated and, to provide for housing the employees, the board owns 245 cottages, most of them with pleasant surroundings and ample gardens.

The total cost of the works to date, including purchase of land, has been about \$10,500,000. The operating cost during the year 1926-27, including interest and repayment of loans, was about \$877,000, which is equal to a charge of approximately 80c per annum for each person within the drainage district.

The above information is taken from the 1928 report of H. C. Whitehead, engineer to the Birmingham, Tame and Rea District Drainage Board.

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## Constructing Pardee Dam

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*A general description of the Mokelumne water project for furnishing a public water supply to the cities east of San Francisco Bay forming the East Bay Municipal Utility District, was given in the June 1928 issue of PUBLIC WORKS. As stated therein, the primary storage reservoir of the project will be the Pardee reservoir, formed by the construction of Pardee dam, which was then about one-fifth completed and is now nearing completion. Some features of the construction of this dam are described in the following article. The pipe lines and tunnels bringing the water from Pardee reservoir to the district were let by contract to a number of different concerns and this work also is nearly completed. The district has recently purchased for the sum of \$33,752,900 the entire property and assets of the East Bay Water Co., a private corporation with a monopoly of service in the communities of the district. This completes the project and it is expected that before the end of this year water from the Mokelumne river will be distributed throughout the district.*

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By James N. Hatch

The Pardee dam (named for George C. Pardee, former governor of California and now president of the East Bay Municipal Utility District) is located on the Mokelumne river about five miles from Valley Springs, California. It will be 360 feet high above the present river bed and will require 625,000 cu. yds. of concrete. After the contract was let, the design of the dam was changed from the arch type, as at first proposed, to the curved gravity, this change being made after the excavation was begun, because it was found that the rock is unsuitable for foundations for an arch type dam.

The reservoir formed will impound 72,344,000,000 gallons or 222,000 acre feet of water, and will cover 2,134 acres of land. The total available storage above the outlet tunnel will be 66,473,000 gallons or 204,000 acre feet. The crest of the dam will be elevation 575 U.S.G.S. and the elevation of the outlet tunnel 392.

The contract for the Pardee dam was awarded to the Atkinson Construction Company for about \$6,500,000, the exact amount depending on the final quantities involved, and is the largest single contract of the project. For carrying on this work the contractor made an initial expenditure for plant equipment and machinery of \$1,250,000, which included the building of five miles of standard gauge railroad from Valley Springs to the dam site, the building of over four miles of aerial tramway across the mountains from the sand and gravel plant to the dam site, and the construction of a modern automatic sand and gravel washing and screening plant.

All the concrete aggregate for the dam is produced at a gravel screening and washing plant which cost about \$250,000, located on the Mokelumne river about five miles down stream from the dam near the old mining town of Lancha Plana, where the river emerges from the narrow canyon into a wide delta. During

the days of '49 the sand and gravel at this point was washed and winnowed by the early miners in cradles and long toms; and again years later was turned over by gold dredges, which left miles of windrows of dredge tailings, which are now being used as the source of aggregate of the Pardee dam. This sand and gravel still contains gold, and when the material is put through the washing and screening plant it is run over a long series of riffles, where a considerable amount of gold is recovered as a first profit to the contractor on his contract. Before deciding upon this material for use in the dam, it was carefully tested and was found to be of excellent quality.

The sand and gravel is dug from the bank with power shovels and hauled about half a mile to the screening and washing plant where it is thoroughly washed of all loam and dirt and then separated into the various classifications required; then rewashed and conveyed on belt conveyors to a storage yard, where it can conveniently

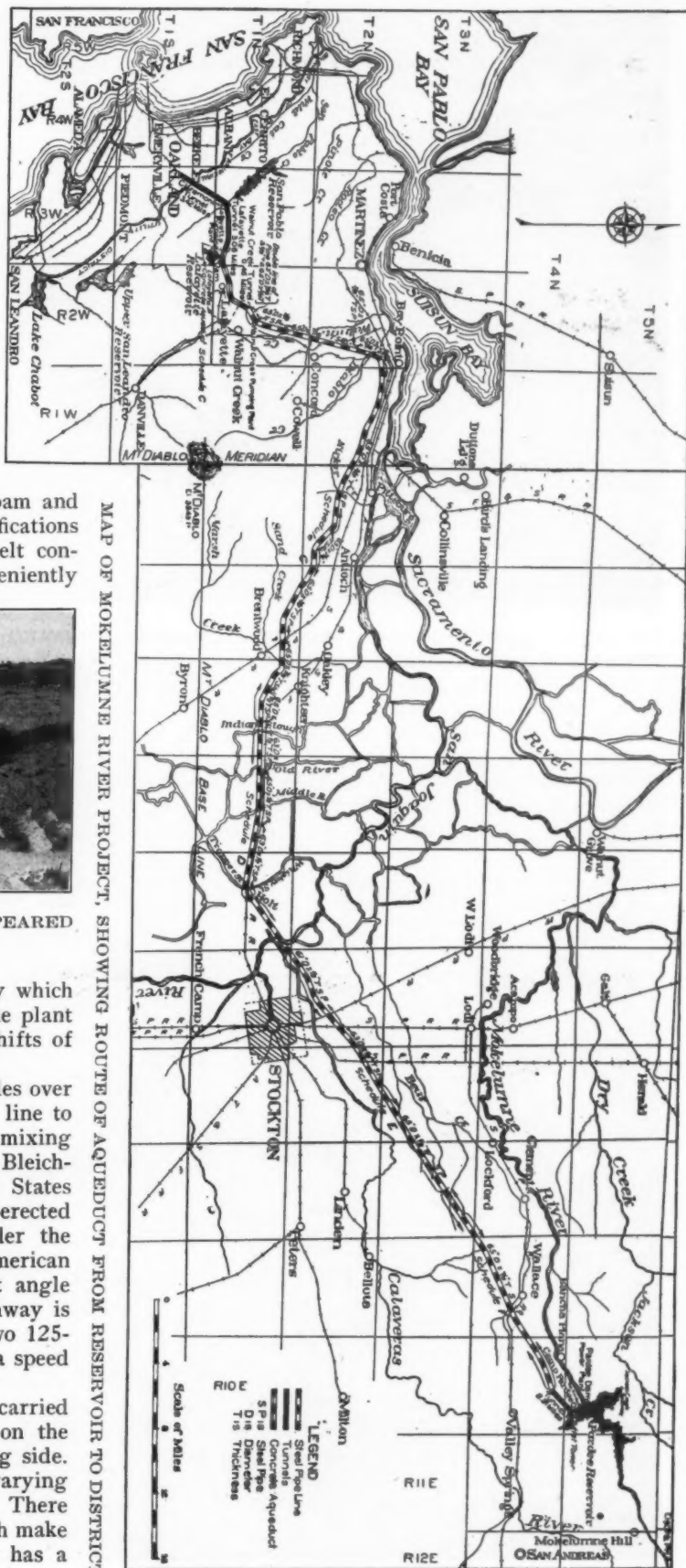


LANCHA PLANA GRAVEL PITS AS THEY APPEARED IN 1927.

be loaded into the skips of an aerial tramway which conveys it to the dam site. The capacity of the plant is 350 tons per hour. It is operated in two shifts of eight hours each.

The tramway extends for more than four miles over the mountains and canyons in almost a direct line to a big bend in the river, which it crosses to the mixing plant on a 1600-foot span. This is a standard Bleichert aerial tramway furnished by the United States Steel Products Company of San Francisco, and erected by the Atkinson Construction Company under the supervision of a tramway expert from the American Steel and Wire Company. There is a slight angle in the line at the top of a ridge and the tramway is operated in two sections from this point by two 125-h.p. motors driving a  $\frac{7}{8}$  inch traction rope at a speed of 470 feet per minute.

The skips are 32 cu. ft. capacity and are carried on locked coil cables,  $1\frac{5}{8}$  inch in diameter on the loaded side and 1 inch on the empty, returning side. The tramway structure includes 34 towers of varying height, anchorages and tension structures. There are 218 skips, spaced about 200 feet apart, which make the round trip in 80 minutes. The tramway has a capacity of 225 tons per hour and is operated continuously night and day except for shut-downs amounting to about ten per cent of the time. The skips are loaded from gravity chutes and are dis-



MAP OF MOKELUMNE RIVER PROJECT, SHOWING ROUTE OF AQUEDUCT FROM RESERVOIR TO DISTRICT

charged, by automatic trips, into storage bunkers at the dam site. These bunkers are probably the largest ever built for a contract of this kind, having a total



#### LOOKING UPSTREAM TOWARD PARDEE DAM

Concreting tower in center. Concrete mixing plant at the left. View taken August 17, 1923. Completed dam will reach the top of the canyon walls shown



#### LOOKING ACROSS PARDEE DAM TOWARD MIXING PLANT AND AGGREGATE STORAGE BINS

In the center is the tower for distributing concrete to the forms. At the right of the tower is seen the concrete mixing shed, and leading from this to the foot of the concrete mixing tower is a flume, which passes through the dam to tower in tunnel. The tower stands in a vertical shaft built in the concrete of the dam as it rises. At the left is a tower of the Lidgerwood cable which spans chasm

capacity of 6,000 tons of sand and gravel aggregate.

The construction camp at the site of the dam is divided into two sections—the main camp, situated on the ridge at the south abutment of the dam, and a subsidiary camp of small cottages to accommodate 40 families a short distance away. In the main camp are the contractors' offices, mess hall, kitchen, etc., and across the street from them are the store, recreation hall, post office, meat shop, etc. The camp will accommodate 400 men and is well appointed in every respect. All buildings are equipped with an exterior sprinkler system for fire protection. The mess kitchen has an electric range, electric water heater, and is provided with a two-ton Yorke ice machine. The buildings are heated electrically and the streets are electric lighted. Electric power is brought in from a power line of the Pacific Gas and Electric Company.

The buildings are painted a uniform dark green color, which fits in well with the landscape. The town is called Atconco, an abbreviation of the Atkinson Construction Company. On a bench nearer the crest elevation of the dam is the blacksmith shop, machine shop and air compressor building, and nearby the saw mill and lumber yard. The water supply for the camp is pumped from the Mokelumne river, through a pressure filter, to elevated storage tanks. In addition to the above, there is what is known as Camp Pardee, about a quarter of a mile back on the same ridge. This camp was built by the East Bay Municipal Utility District for the accommodation of the resident engineers employed on the work. There is a group of buildings consisting of a lodge, dining-hall cottage, and six bungalows. This portion of the camp is to be permanent and will be used by custodians of the dam and operators of the power plant when



GENERAL VIEW OF CAMP PARDEE, TAKEN FROM WATER TANK

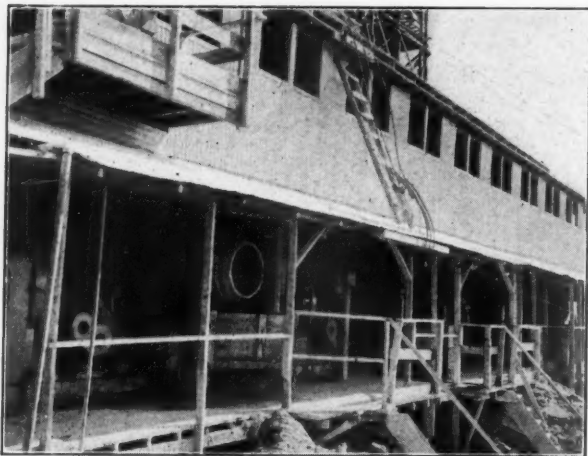
the construction work is completed. The camp was designed and laid out by an architect and is very attractive. The buildings are painted white with green blinds and have asbestos shingle roofs. They are grouped around an oval park in among the pines and liveoaks.

The concrete aggregates are stored near the mixers in storage bunkers which are kept filled by the skips of the aerial tramway. The bunkers are built without bottoms, the material resting directly on the ground. Cement is received in cloth sacks, in carload lots, from the mills of the Calaveras Cement Company about ten miles away. The sacks are emptied into a hopper, and the cement conveyed on a belt conveyor to a cement silo where it is kept in storage. From the silo it is conveyed by screw conveyors to cement weighers located above the mixers. There is a battery of four 56-S Smith mixers of 2-yard capacity which rest on a concrete apron at the base of the bunkers. The cement is weighed for each batch, but the aggregates are measured in a Blaw-Knox batcher and delivered



SAND AND GRAVEL PLANT AT LANCHA PLANA

In the left foreground, loading bunkers for loading the skips of the aerial tramway. Fine and coarse aggregate stored in piles at right. Under these runs a tunnel equipped with a belt conveyor, onto which the material desired can be discharged through gates and by it be taken to the loading bunkers. Washing and screening plant is shown in the background.



CLOSE-UP OF THE FOUR TWO-YARD CONCRETE MIXERS

to the mixers on a 30-inch belt conveyor. No pains have been spared to make the plant sturdy and reliable in an effort to avoid breakdowns and delays.

A concrete placing tower 265 feet high was erected when work was first begun. As the concrete was built up above the base of the tower a tunnel was built around the chute that brings the concrete to the elevator bucket, so concrete could continue to be delivered to the base of the tower and elevated in the same manner, until concrete placing is finished, when the tower and chute will be removed and all the space filled in solid.

A hydro-electric power station is being constructed immediately below the dam, which will have a capacity of 15,000 kilowatts. Power from this station will be carried by a high-tension line into the Bay cities. It is expected that the East Bay Utility District will itself use most of the electric power and no substantial revenue is contemplated from the sale of power. Two hydraulic generators of 7,500 kilowatts each are being installed in the power station.

### Liquid Chlorine Injunction Extended

In November, 1927, a preliminary injunction was granted the Electro Bleaching Gas Co. and Wallace & Tiernan Co. against the Paradon Manufacturing Co., restraining the latter company from selling certain apparatus for chlorinating water. Under date of August 6th, 1929, Judge Fake extended the injunction, pending a suit still in the courts, restraining the Paradon Manufacturing Co. from using, making, selling, installing or rebuilding "apparatus using a means of mixing the chlorine with a minor flow and designated by the defendant corporation as types DI, DBI, TS and T, with or without the 'Bull Pot' attachment," or in any way infringing upon claims 4, 5, 6, 8 and 10 of U. S. Patent No. 1,142,361.

### Preparing for Street Improvements

For many years past it has been the custom to authorize the majority of street improvements at such a late date that the season is well advanced, if not practically gone, before construction is commenced. It would be very advantageous to all concerned if the preliminary work—notice of intention, notice to

contractors, etc.—were disposed of during the winter months and the contracts let during February and March. A great deal of delay is often occasioned by opposition developed during the publication of the notice of intention. The City is, of course, unable to determine the desires of the property owners until such notice is published. In order to obviate these difficulties, and to insure the work being started earlier in the season, I would suggest the following procedure: that the Board authorize publication of notice of intention on a number of desirable improvements—paving, curb and gutter and sidewalk; from the published list, authorize those on which property owners generally favor the project. All these improvements could be published in one notice, and, since a large portion of such notices are merely repetition, a considerable saving could thus be effected in advertising cost.—*From the annual report of Harry C. Jessen, city engineer of Salt Lake City.*

## Concrete Road Plants

**Selection of machinery, its assemblage into a plant and efficiency of its employment. Standard methods briefly described**

Among the papers read at the spring meeting of the American Society of Civil Engineers, was one before the Highway and Construction Division by Tyree L. Bell, Jr., general superintendent of F. P. McElwrath Company, of Corsicana, Texas, entitled "Concrete Road Building Plant and Its Operation." In a digest of these papers and discussions in the August "Proceedings" of that Society is included quite a lengthy digest of Mr. Bell's paper, which we have abstracted in the following article.

Introducing his paper, Mr. Bell stated that he had attempted merely to outline what is orthodox in concrete construction with reference to equipment and methods, giving some experiences and suggestions for operation. He said that, while doing good work, the contractor aims also to profit from his work, and his opportunity of doing so "is dependent largely upon the machinery which he uses and the efficiency of the labor which he employs. Therefore, the selection of machinery, its assemblage into a plant and the efficiency of its employment are of paramount importance to the contractor." Efficiency does not come accidentally nor through energy and enthusiasm alone, but "ordinarily results from careful, systematic planning, from the determination of some specific course by which a desired result can be had, and then from setting about with tireless persistence to follow that course. It is the result of careful planning, hard work and good management."

The contractor should acquaint himself as fully as possible with the machines available for his purpose and select from them those best fitted for his proposed plan of operation; then perfect the use of them until they give regularly all the service of which they are capable; and coordinate the functions of all the machinery into a smoothly running plant. Mr. Bell believes there is very little profit in record runs ex-

cept in the case of an occasional spurt for advertising purposes. The most profit will probably result from a program of steady, uninterrupted production.

To secure this, each operation should be performed at a rate which harmonizes with all of the others. The paving mixer is the key, the pacemaker, for the entire plant. Each of the other machines and the crew must be selected and scheduled to operate a little in excess of the capacity of the mixer, so that short delays on their part need not affect the output of the mixer. Having chosen the larger machines, the contractor will find it worth while to study the economies in various special hand tools and other innovations developed to fill some particular need.

In the selection of the crew, he will take into consideration the fact that machinery has largely replaced manual labor, and that therefore such labor as is employed must be of a higher quality than formerly.

Work on rough grading can hardly be standardized for all localities, since the nature of it varies so widely. The topography of the country, the nature of the soil, and the season of doing the work, all require consideration in determining how the rough grading should be done. The methods of grading have not themselves been improved as much as has the surfacing. "The Fresnoes and wheel scrapers of the south and southwest still keep the price of dirt work at such a low figure that it is not sufficiently attractive to interest the efforts of alert contractors." In other sections of the country where the grading is heavier, the steam shovel, drag line, elevating grader, and the new crawler wagon seem to prove satisfactory.

To be sure that the mixing plant can operate continuously, it is necessary to have on hand at all times, usually in a material yard, an adequate supply of materials available for transportation to the mixer. The equipment for such a yard includes a crane, overhead bin equipped with measuring devices, and special trackage and cement warehouse. He recommends the crawler type crane, full revolving and handling a clam shell bucket ranging in size from  $\frac{3}{4}$  yard to  $1\frac{1}{4}$  yards. "If the capacity of the crane and the skill of the operator are sufficient, all the unloading and proportioning sufficient for the full requirements of a seven-sack mixer can be accomplished during daylight hours with one crane. Quite frequently, however, it is found that a night operator it necessary to unload out of cars into storage, enough of the materials to free the regular operator from a part of the car unloading, that he may concentrate on keeping the bins full by digging largely from the stock piles. Greatly increased operating speed can be obtained by loading directly from the stock piles to the bins, rather than from tightly packed cars."

Crane, bins and stock piles are ordinarily set near the middle of an unloading track, the necessary length of which is twice the combined length of a string of cars long enough to hold the usual amount of material needed for one day's work. The reserve stock piles should be provided as a source of aggregate supply if regular shipments of aggregate are delayed in transit. Storage of cement should be governed by the same conditions; in addition to which a space should be available for emergency storage of cement which comes in while the job is shut down.

Bins should be rigid and strong enough to with-

stand unusual and erratic loading, and at the same time be so light they can be moved economically.

Measuring aggregates by weight is an accepted and established practice, and is specified by certain highway departments and favored by others. "Several manufacturers offer weighing batchers that are entirely satisfactory in operation and comparatively inexpensive. Changes in the sizes of batchers can be made accurately with ease and with absolutely no delay." The use of bulk cement with the help of bucket elevators, screen conveyors, and proper weighing devices offers an opportunity for economy.

For hauling to the mixers one, two or three batches of proportioned materials Mr. Bell considers a heavy truck the most flexible and adaptable transportation means available. The present tendency is toward multiple-batch rather than single-batch trucks. Most contractors hire trucks on a batch-mile basis. There should be a sufficient number of trucks so that there will always be at the mixer enough trucks standing by to remove any possibility of the mixer waiting for a batch. The number necessary is dependent upon the speed of the truck, the length of the haul, and the time required at the material yard for batching. The contractor will find it to his advantage to expend money in the maintenance of roads which will assist the trucks to maintain their full speed without having to slow down for bad holes or barriers. It may often be economical to use turntables for turning trucks.

The first cost of narrow gauge equipment is high, and the cost of transporting it from job to job and the delay in setting up the equipment are likewise high as compared with the more mobile truck. Nevertheless, trains can be organized and run on more dependable schedules after the construction line has been established, so that Mr. Bell recommends a combination of narrow-gauge railroads and trucks when the length of haul is long enough to warrant it.

The water supply of a concrete paving job is a most important feature and it is found by the Bureau of Public Roads that more time is lost in paving outfits from a failure of water supply than from any other one cause, except faults of management. Pumps have been designed especially for road building which will supply from 80 to 120 gallons per minute against a 500 lbs. pressure. During the hottest part of a Texas summer, from 40,000 to 60,000 gallons of water per day are sometimes required. Although a single standard road pump may be able to meet these conditions by doing some of the curing at night, it is better practice to provide two independent pumps. When two pumps are used, it is desirable to keep one ahead of the mixer, the other behind the mixer furnishing curing water. By having water supplied from two independent sources into a single line of pipe, in the event of a shut-down of either pump, the other can temporarily supply the needs of the entire job. For pipes, black iron pipe is standard practice. It should be laid in a ditch so that leakage from it will drain away from the job. Instead of 2-inch pipe, contractors now are using  $2\frac{1}{2}$  and 3-inch pipe, figuring that the decrease in friction as well as greater capacity of the larger pipe would offset the added purchase cost and transportation charges. There should be a relief valve at the pump and another at the mixer, to come into use in the event of sudden stoppage. It is recommended that outlets be provided every 500 ft. and

two lines of mixer hose 300 ft. long, one of which can be used while the other is being moved ahead.

Tools and the method for setting forms are pretty well standardized. Strong, rigid, well set forms are necessary to secure a smooth-riding pavement. Forms should be supplied in amount at least twice that of the maximum day's run. The farther in advance the forms are kept, the more economically the sub-grade crew works. Maximum strength and rigidity are desirable in forms. After the forms have been set, the sub-grade ordinarily is scarified thoroughly to a depth of 0.2 ft. and a sub-grading machine is pulled along the forms, making an initial cut and leaving the sub-grade slightly above the net grade, spreading the excavating material uniformly along the shoulders. The sub-grade then should be rolled slightly with a power roller, preferably one weighing from 3 to 5 tons; after which the sub-grader is again run over it, making a cut to the exact net lines of the section. These of course precede the paver, and another sub-grading machine called a trail grader or sub-grade paver often is pulled behind the paver.

For mixing, the seven bag size of mixing machine is generally used. As stated before, the mixer is the pacemaker for the entire operation. Under a one-minute mixed specification, a cycle of full operation will range from one minute and ten seconds to one minute mix specification, a cycle of full operation are available for controlling the cycle of the operation, but are not generally used as yet, as a rule, and an alert operator can get out of the mixer its maximum capacity provided the other elements of the plant function properly. To develop the full capacity of the mixer, the operator must be able to make it hoist, mix, dump, and travel simultaneously.

Mr. Bell recommends mechanical finishing machines in preference to hand methods, but states that best results cannot be obtained unless the form line is rigid and straight and the concrete of uniform consistency. In such conditions, he believes that a properly functioning machine will secure a uniformity and mechanical exactness which is not possible with hand tools.

The demand for greater refinement of shoulders has led to the development of machines the finished work of which should please the most exacting. Such machines, running on the pavement and with blades gauged by the edge of the slab, cut the shoulder and slope to the exact section of the plans. Both, however, are dependent on an adequate supply of loose material on top of the shoulders.

Chemicals are being used more and more to aid in curing concrete pavements, but the old method of sprinkling earth or hay coverings, and ponding, are still largely used.

## State Road Construction Near Liberty, N. Y.

**Equipment used for heavy grading. Mixer hose supported above traffic on side of road left open**

Fifteen miles of highway are under construction on Route 17, New York State, between Monticello and Livingston Manor, in Sullivan County, in the lower Catskill section. This road, which carries an exceedingly heavy traffic throughout the summer months, and considerable traffic throughout the entire year, is being widened, straightened, and surfaced with concrete. The work is being done under two contracts, one covering about 7 miles between Monticello and Liberty and the other about 7½ miles between Liberty and Livingston Manor.

Between Monticello and Liberty, the old road was of bituminous penetration macadam, laid nearly 20 years ago. This road has given excellent service, but is too narrow to accommodate the present-day volume of traffic and there are several curves dangerous under heavy traffic conditions. From Liberty to Livingston Manor, the road originally was principally of Hassam concrete, laid about 1909, and surfaced a few years later with a thin layer of penetration macadam. This road, also, was narrow, and had bad curves and some heavy grades.

The new road will be 20 feet wide, and curves and grades have been improved to comply with modern traffic demands. Provision is made for another traffic lane of 10 feet, whenever this shall become necessary, but for the present only two lanes of 10 feet each will be constructed.

The strip of road running north from the village of Liberty is being constructed by the Fitzgerald Bros. Construction Co. of Troy, N. Y. Charles Crawley is superintendent for the contractors and Thomas Rogers is resident engineer for the state.

There are some heavy cuts on this section, especially at Kimball's Mill just north of Parksville, where a deep cut and fill had to be made to eliminate a very bad blind curve. On this work, the contractor used a Bucyrus-Erie gas-air shovel, with a 1-yard bucket and a Koehring gasoline shovel with a ¾-yard bucket. Spoil was carried in motor trucks, 3-yard Autocars being used principally. On some of the soft fills, a Linn tractor mounted on crawlers was used and gave excellent service. Gravel from the bed of the Little Beaverville was used for some of the fills and also as a subgrade material in the cuts.



PNEUMATIC TIRED TRUCK USES SUBGRADE WITHOUT DAMAGE TO SAME



HOSE ELEVATED, ALLOWING TRAFFIC TO PASS UNDER IT

An Austin grader equipped with a McCormick-Deering tractor and a horse-drawn Climax grader were used on grading work.

The aggregate for the concrete was shipped from Haven, N. Y., to Parksville, where a Blaw-Knox aggregate bin was located. The aggregate was unloaded from the cars by a Koehring crane equipped with a half-yard clamshell bucket directly into a Blaw-Knox bin equipped with an adjustable measuring batcher, which loaded batches of sand and stone into the trucks. A stock pile was also maintained at this point, which is about midway of the section under construction.

Autocar trucks with bodies and hoists supplied by Fitzgibbons & Crisp of Trenton, N. J., brought the aggregate to the mixer, each truck carrying three 7-bag batches. The trucks were equipped with Firestone pneumatic front, and solid rear tires, and operated on the subgrade without injury to it. The short wheelbase was of value in quick turning in cramped quarters, so that, except when traffic interfered, there was little delay at the mixer. The number of trucks hauling aggregate to the mixer varied, but on the longer hauls nine trucks were generally used.

A Multi-Foote 27-E Mixer was used, and Blaw-Knox forms. Reinforcing steel was supplied by the Concrete Steel Company and Nazareth Portland Cement of a high early strength was used, enabling the contractor to open the road to traffic in an average of about seven days. Expansion joints were placed 78½ feet apart. Finishing was accomplished with a Lakewood screed powered with a Novo engine. The fresh concrete is protected by canvas, and cured with hay.

Water was provided through a 2-inch line about four miles long from a creek near Parksville. Outlets were spaced about 400 feet apart. The method of carrying the hose over the completed section of the road so as to avoid injury by the constant heavy traffic, shown in the accompanying illustration, was accomplished by using a pole which was bolted to the top of the mixer and projected across the lane in use. Due to the heavy traffic, hose laid on the road bed had to be replaced every day or two.

An average of twelve men were employed in the mixing and finishing gang, as follows: 4 men spreading; 1 man spading; 2 men ahead of the screed; 1 man directing the trucks carrying the aggregate; 1 man on the screed; 2 men handling the steel; and 1 mixer man.

Subgrading was carried on ahead of the mixer by a small gang, following rough grading with the Austin-Western. Only light hand work was necessary, the gang equipment, besides hand tools, consist-

ing of a Buffalo-Springfield roller and a light truck.

The work includes the construction of several bridges and culverts over branches of the Little Beaverkill, none of them large. At places, steam shovels did the major part of the excavation. The bridge gang used Jaeger T-L mixers for concreting.

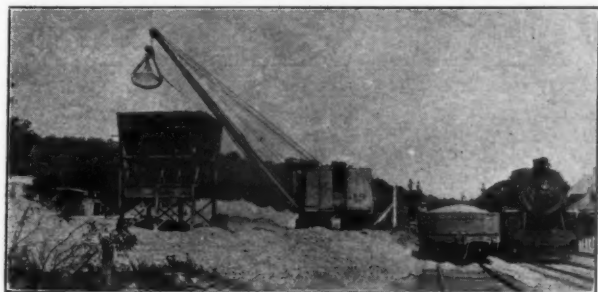
J. B. Orr and John McAree were inspectors for the State on the mixing and finishing work.

## Bergen County, New Jersey, Highways

**Extensive developments necessary to meet traffic conditions which will result from completion of Hudson river bridge. Heavy rock cuts necessary in grading highways.**

**By Lester H. Burns**

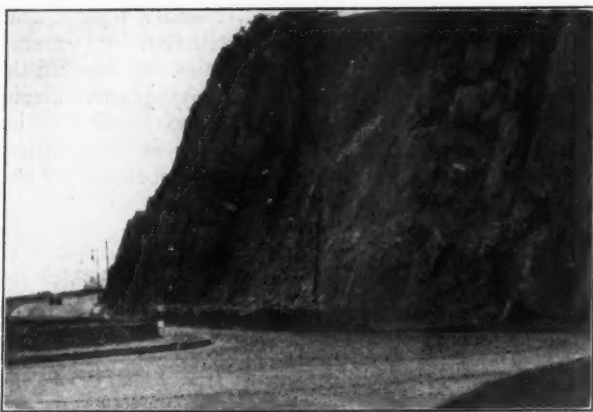
The completion of the bridge across the Hudson River connecting New York City with Bergen County, New Jersey, will greatly increase the traffic problem which already exists in that county. This bridge will form an important link in the highways planned for the development of transportation facilities at the Port of New York, and also in several national highway routes. The highways of this county are already overtaxed by existing traffic, but studies made by the Port of New York authorities indicate that over 9,000,000 motor vehicles will cross the new bridge into Bergen County the first year after it is opened, much of which traffic will be new, created by the new transit facilities. To provide for this increase in traffic and to divert it around the centers of population, dual highways must be built and completed before the bridge comes into use. The County Highway Engineers have made an exhaustive study of the problem, and have completed the routing and location



LOADING BIN AT SIDING



HIGHWAY SYSTEM FOR NEW YORK AND ITS ENVIRONS



HEAVY ROCK CUT ON ROAD UP THE PALISADES

of the new highways, except for a few details such as the width and exact location of some of the roads.

Bergen County's traffic problem is due chiefly to its location. To the north and west of it lie the great summer playgrounds of New York City; across the Hudson River lies all of the Greater City of New York; while to the south is a large industrial area and a series of urban centers. The Holland Tunnel has now reached almost its capacity of traffic and it is probable that with the completion of this bridge a considerable part of the traffic between New York City and the south and west will use the bridge, passing through a part of Bergen County to do so. The bridge will be in a direct line between the various Boroughs of New York City, and the Catskills, Adirondacks and other summer resort countries north of there.

Two ferries now connect Bergen County with New York City, and during 1928 the ferry at 125th Street, New York, carried 2,665,644 vehicles, while the Dyckman Street Ferry, several miles further upstream, car-

ried 1,062,257 vehicles. No accurate check is available on the number of vehicles entering Bergen County from the south but all agree that it exceeds 4,000,000. Including the vehicles registered in the county, it is believed that over 8,000,000 motor vehicles use the 1348 miles of improved highways in the county each year. From figures collected by the New York Port authorities it is estimated that the annual traffic will reach a total of 17,000,000 by 1932. In addition to the traffic from the south and southeast to the west side of the Hudson, which will cross the bridge, there will be a large amount between the New England States and the New Jersey shore resorts. The bridge will also, in connection with the Washington Bridge over the Harlem River and the proposed Tri-Borough Bridge crossing the East River, form a new uninterrupted highway between Long Island and New Jersey.

Bergen County's topography is characterized by a series of hills and valleys. From the Palisades along the Hudson, west to the Ramapo Mountains, sharp grades are encountered and many of the new highways will have to be cut through hills, which it would require undesirable grades to climb over, and which could not be skirted without adding greatly to the length as well as the cost of construction and maintenance.

This highway problem is being worked out under the supervision of the State Engineers, the County Engineers and the Port Authorities. While the new highways will be constructed by the state, the county roads will be feeders to these and must be in good condition if congestion is to be avoided when the bridge and main highways are opened to traffic. The county road department, therefore, under the direction of the Board of Freeholders, is busy repairing and remaking the county highways. For the past four years, the number of men employed by the department has been fairly constant, averaging about



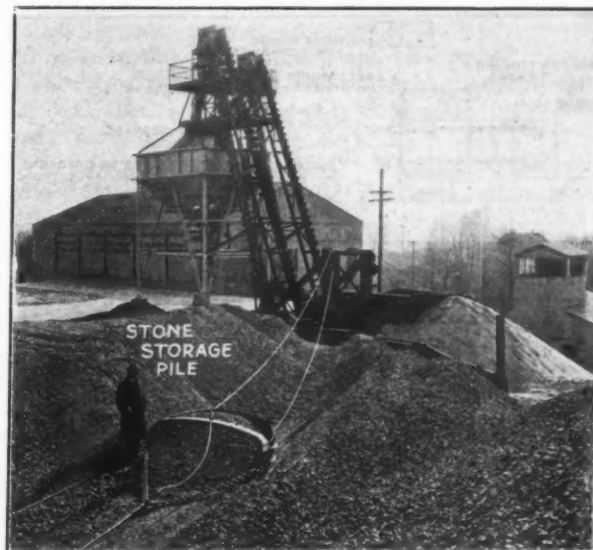
NEW JERSEY APPROACH TO BRIDGE ON MARCH 7, SHOWING DEEP ROCK EXCAVATION.  
Courtesy of Port of New York Authority.

200 engineers, laborers, clerks and road builders. The department uses the most modern type of equipment including 5 and 7-ton trucks, none more than 2 years old, steam rollers, steam shovels, air compressors, and other modern road building equipment, the use of which has saved the county large sums of money during the past two or three years.

In constructing this road, the county has found it necessary to do considerable rock cutting, but probably not nearly as much as will be required by the new roads now being planned. In the northern part of the county, the rock formation is the same as the hard trap rock found along the Palisades; while in the southern part heavy clay shales predominate. Steam shovels can be used in breaking down some of the shales, although even in them compressed air tools must be used to a great extent. In the north, drilling and blasting are necessary, and steam shovels can only be used for stripping off the overburden and removing the broken up rock.

## Utilizing Rock From Hudson River Bridge Construction

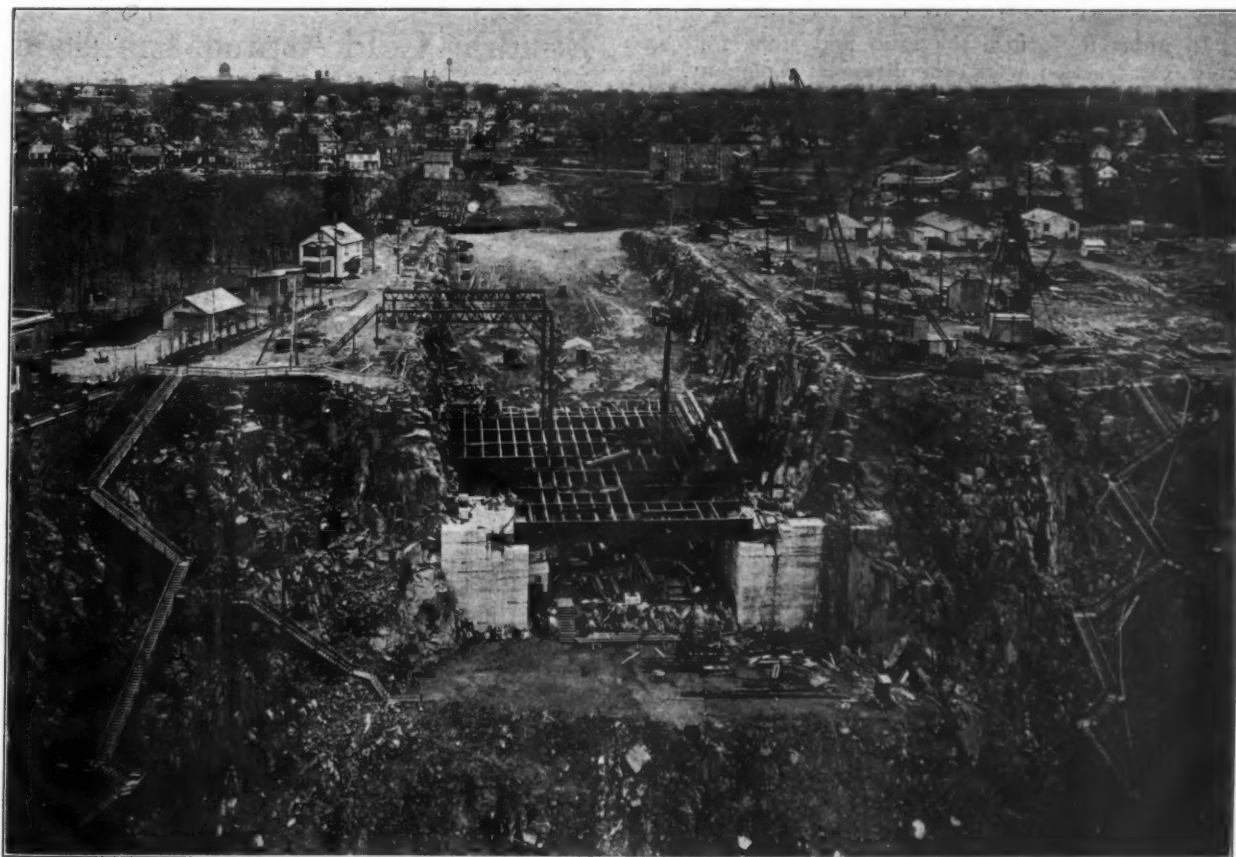
As already described in previous articles, the construction of the new suspension bridge across the Hudson river between Fort Lee, N. J., and New York City necessitated the tunneling of the Palisades for an anchorage for the cables, and also the making of a deep cut extending through the Palisades and connecting the roadway of the bridge with the highways in the rear of the Palisades. The stone



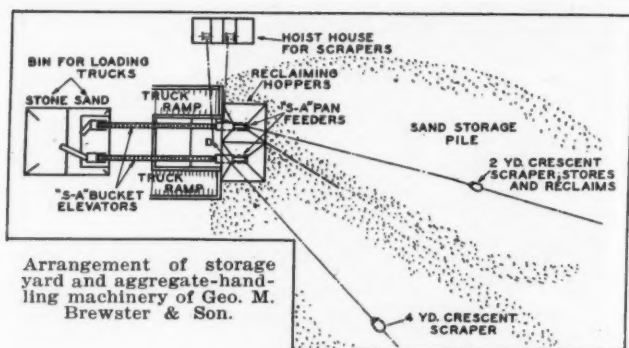
VIEW OF MATERIAL-HANDLING MACHINERY  
Bucket elevators draw aggregates from pan feeders, which are filled by scrapers.

excavated is a very hard trap rock which, when cut and sized, makes a very valuable material for concrete work.

The bridge contractor built a crushing plant of 1000 tons per day capacity, but, finding it impracticable to market the stone as fast as it was produced, arranged with George W. Brewster & Sons, Inc., contractors and supply dealers of Bogota, N. J., to take the entire output as it was produced. The Brewster Company built a storage yard at Fort Lee



NEW JERSEY APPROACH TO BRIDGE ON APRIL 17, STEEL WORK OF APPROACH UNDER CONSTRUCTION



about a quarter of a mile from the crushing plant, where provision was made for storing this stone and sand, and for reclaiming the material for delivery when it may be sold.

Stone is brought from the crushing plant in motor trucks, which are backed up on ramps and discharged into the path of crescent drag-line scrapers. A 4-yard scraper stores the stone, while a 2-yard scraper stocks sand as it is delivered. The same scrapers reclaim these materials from the storage pile and carry them to the delivery bins, each scraper discharging into a separate hopper. Stephens-Adamson pan feeders draw the material from the sand and stone hoppers and it goes into S. A. bucket elevators, consisting of continuous steel buckets mounted on rubber belts, which elevate the material into separate compartments of the delivery hopper. Stone is reclaimed in this way at the rate of 120 tons per hour and sand at the rate of 85 tons per hour. Electric motors drive the feeders, elevators and scrapers. The bins and machinery supports are of structural steel construction.

In order to furnish the sand and stone for concrete construction work, the Brewster Company has installed accurate measuring gates under each section of the delivery bins, for discharging accurately measured, predetermined quantities of sand and stone into trucks for transportation to the concrete mixing plants.

The engineering work on the storage and reclaiming system described was performed by W. W. Blauvelt, chief engineer for George M. Brewster & Sons, and his assistant, A. E. Scrivens. The installation is being operated by Gus Frank, and is under the supervision of General Manager Rittman.

### Prequalification of Contractors Favored by Western Highway Officials

The Association of Western State Highway Officials, which includes eleven of the western states, at its annual convention in July discussed the prequalification of bidders, most of those entering into the discussion favoring the plan.

"Under the old system," said C. H. Purcell, state highway engineer of California, "we were forced to weed out incompetents after bids were received, and it was a difficult proposition to convince either the hopeful contractor, or the general public, that there was a good and sufficient reason for awarding the contract at a higher figure than the lowest one submitted."

It was pointed out that the fact that the bidder had submitted a bond was taken, by those who did not

know the customs of surety companies, as proof that the low bidder must of necessity be financially capable of handling the work. This feature was mentioned by several officials as one that made it almost impossible to weed out the unfit without having rumors of favoritism or worse circulated immediately.

"Since adopting this system," said Dr. L. I. Hewes, deputy chief engineer of the Bureau of Public Roads, "we have had approximately one hundred bidders, and have disqualified only three." In answer to an inquiry, Dr. Hewes explained that when there was any doubt, as in border-line cases, the contractor was given the benefit and was allowed to bid.

"In California the law leaves it to our discretion as to whether or not we shall demand prequalification," explained Mr. Purcell. "At present we are going slowly, handling only the extreme cases, though we expect to become more severe as we get our standards established."

One danger in prequalification was mentioned by an official, that of giving to the successful bidder an opportunity to secure too great a line of credit, on the argument that the state had placed its approval upon his firm. In one or two instances stock had been floated by construction companies which used this argument, and the state had difficulty in explaining away an embarrassing situation.

On the other hand, Dr. Hewes looked forward to the day when none but prequalified bidders could submit figures. "Then," declared the speaker, "we may induce bonding companies to reduce their premiums, as we will have done what they have so far failed to do—examine into the fitness of the applicant for the surety."

## Building Cold Asphalt Emulsion Road in Canada

Methods and Equipment Employed in Constructing a 3½-Mile Section of Road at a Cost of \$3,500 per Mile

Along a section of Road No. 24, near Brantford, Ontario, Canada, a 9-foot strip of concrete pavement had been built on one side of the road to carry heavy and fast traffic, while the rest of the roadway was surfaced with gravel. By this construction, a hard-surface road was provided for usual traffic conditions, and the initial cost was reduced materially over what would have been required for a full-width surfacing of concrete.

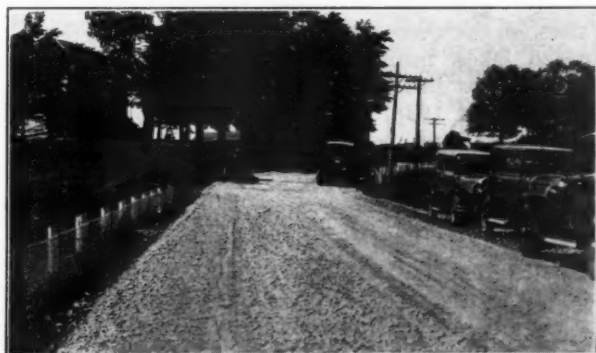
However, the gravel section wore so rapidly under the summer traffic that maintenance costs were high and the road was dusty and unsatisfactory for travel. A tar treatment, while eliminating the dust nuisance, was not able to restore the road, which required rebuilding for satisfactory service; and it was rebuilt this year, using a cold asphalt emulsion in the manner described below.

The old gravel was scarified, and the sub-grade trued up with a blade grader, after which a 1½-inch course of pit-run gravel was spread by truck, the body being raised to dumping position and the tail-gate opened 2 inches, and held by chains. The amount spread was regulated by the speed of the truck, and delivery was sufficiently exact to be satisfactory.

Following this, an emulsion known as Colas was applied with a pressure distributor at the rate of one-third of an Imperial gallon per square yard, and a cover layer of  $\frac{1}{2}$ -inch washed gravel was spread immediately by truck in the manner mentioned above. The road was then thoroughly rolled with a 12-ton roller, and a second course of  $\frac{1}{2}$ -inch washed gravel applied.



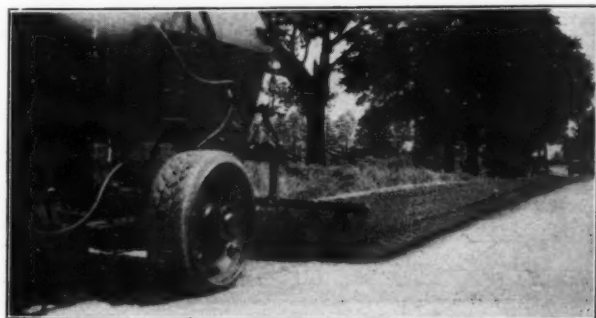
DISTRIBUTING GRAVEL BY TRUCK



ON THE RIGHT, CONCRETE SURFACE. ON THE LEFT, ROAD PREVIOUS TO FIRST APPLICATION OF EMULSION. NEAR BRANTFORD, ONT., JULY, 1929.



HOME-MADE WATER TANK DAMPENING AHEAD OF DISTRIBUTOR



APPLYING EMULSION TO GRAVEL

Following this, another application of one-third of a gallon of Colas was applied, and pea gravel spread at once as a binding material. A final thorough rolling was then given the road, which was opened to traffic for a few days.

A seal coat was then applied consisting of an application of one-third gallon of Colas per square yard and a covering of pea gravel. The road was then thoroughly rolled.

Equipment employed on this job was as follows: Two 2-horse blade graders; two 3-ton dump trucks; one 12-ton roller; one 500-gallon water tank (a home-made outfit devised from materials at hand); and one tank truck distributor for applying the Colas. The personnel consisted of one superintendent, one foreman, one laborer, and eight operators for the above mentioned equipment. The material was clean washed gravel, run-of-pit,  $\frac{1}{4}$  to  $\frac{1}{4}$ -inch sizes, clean washed gravel cover material of  $\frac{1}{2}$ -inch size, and pea or torpedo material.

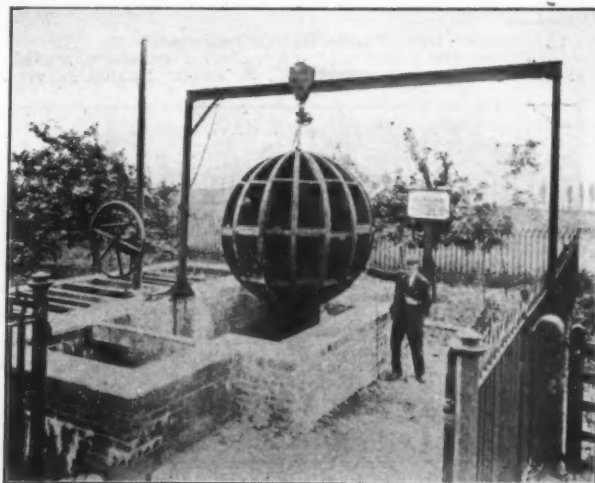
The cost of this work, which resulted in a wearing surface approximately two inches thick of dense gravel aggregate well bound together, amounted to \$3,500 per mile. It is expected to maintain the surface by annual surface treatments consisting of about a quarter gallon of Colas per square yard and pea gravel.

During the construction, traffic was not delayed nor was any section of the road closed to traffic. Automobiles were permitted to travel over any section at any time, with no bad results and with no pick-up of material. In applying the gravel layers, the trucks passed directly over the newly applied Colas without difficulty or injury.

### An Eight-Foot Sewer "Pill"

Sewerage engineers and superintendents are more or less familiar with the so-called sewer "pill"—a ball, usually made of wood, used for cleaning sewers, the ball being inserted at a manhole into a sewer one or two inches greater in diameter than itself, and allowed to float through it with the sewage, the greater velocity caused by the concentration of sewage between the ball and the side of the sewer acting to stir up any sediment in the sewer.

We do not remember to have heard of such pills being used for large sewers in this country; but Birmingham, England, has been using one for clean-



AN EIGHT-FOOT SEWER "PILL"

ing an eight-foot sewer which connects the Saltley and the Minworth plants of the Birmingham sewage district. A special reason for cleaning this sewer was to prevent putrefaction of deposits in the sewer, so that the sewage might reach the bacteria beds in as fresh a condition as possible. Cleaning by manual labor was costly and could be carried on only at rare intervals. Sterilizing by means of chlorine also was expensive and could be carried on only to a limited extent for fear of causing harm to the bacteria beds. About 1927 it was decided to try keeping the sewers clean

by means of a wooden ball or pill somewhat smaller in diameter than the sewer. This ball is dropped into the sewer at Saltley, rolls along on the arch of the sewer, and the obstruction to flow which it causes produces a vigorous scouring action along the invert and sides of the sewer, which thoroughly removes growths and deposits. At the end of the journey, at Minworth, the ball is hoisted out of the sewer and returned by motor truck to Saltley. The sewer is cleaned in this way at frequent intervals during the summer months.

## Applying Paris Green as an Anopheline Larvicide\*

Equipment developed for dusting small vegetation-covered lakes, mill ponds, bayous and similar bodies of water, economical where no other known method of larval control is feasible

By J. A. Le Prince† and H. A. Johnson†

The value of diluted Paris green dust as an anopheline larvicide has been known since 1921. In that year Dr. M. A. Barber, director of the malaria research laboratory of the United States Public Health Service, discovered the high toxicity of this poison for *Anopheles* larvae and established the practicability of hand dusting with diluted Paris green as a valuable method of *Anopheles* control. This method is especially valuable where dense vegetation is present or the water is covered by debris.

During 1922, 1923 and 1924 W. V. King and G. H. Bradley, of The Bureau of Entomology, Department of Agriculture, carried on successful experiments with Paris green distributed from airplanes near Mound, La., and demonstrated the effectiveness of the method against anopheles larvae. In 1926 and 1927 Surg. L. L. Williams, Jr., of the Public Health Service, working with Lieut. Commander S. S. Cook, of the United States Navy, at the Marine Barracks at Quantico, Va., obtained excellent results in dusting Paris green from airplanes, as described in PUBLIC WORKS in the issue of April, 1927.

There has developed a distinct need for a mechanical dusting device to make possible the economic control of *Anopheles* breeding areas of approximately

1 to 100 acres on the upper reaches of impounded waters, on overgrown swampy areas, small vegetation-covered lakes, fishing ponds, mill ponds, and even large bayous. In view of this need, the writers, during the season of 1928, attempted the development of a device that could be used in a satisfactory way by health authorities as their malaria problems might suggest.

The first trial was made with a boat operated by an air propeller and therefore possible of operation on vegetation-covered water. While it was found possible to use this device for a blower and to dust successfully, it was observed that the most satisfactory dust clouds were made with a very low engine speed, and the idea was abandoned.

**Equipment Used.**—In view of the nature of the *Anopheles* breeding places, it was thought best to select portable units of light weight and to use them in a light skiff-type of boat. The following equipment was procured:

1 skiff type rowboat, 14 feet by 52 inches.....	\$ 70.00
1 outboard motor .....	140.00
1 portable gasoline-driven electric generator unit, 110 volts, weight 108 lbs.....	225.00
1 centrifugal fan-type electric blower, 110 volts, weight 8 pounds, with inlet flange and 1/4 inch suction hose .....	50.00
1 hopper, for dust delivery.....	12.50

\$497.50



THESE ILLUSTRATIONS SHOW THE CONDITIONS EXCEEDINGLY FAVORABLE FOR MOSQUITO PRODUCTION IN REELFOOT LAKE AND THE PROTECTION AFFORDED BY THE HEAVY GROWTHS

\*Abstracted from Public Health Reports.

†Senior sanitary engineer and technical assistant in sanitary engineering, respectively, U. S. Public Health Service.

The generator unit consists of a 1-cylinder gasoline engine driving a 110-volt electric generator. The two are combined into a single unit weighing 108 pounds and developing 600 watts (0.80 horsepower). This unit is set on spring legs to reduce vibration, does not require bolting down, is entirely automatic in operation, and is easily moved from boat to boat.

The blower is a 110-volt electrically driven unit, weighing about 8 pounds, requiring 0.16 horsepower, and is connected with the generator by a flexible wire cable such as is used with a vacuum cleaner. It is held in the hand or can be fastened to the boat's side and can be operated from any position and at any angle desired. The blower has a theoretical nozzle velocity of about 15,000 feet per minute and moves 45 cubic feet of dust-laden air per minute.

In the earlier tests the dust was fed unto the blower by dipping the suction hose into the dust and withdrawing it. It was observed that the cutting off of the intake air supply of necessity cut down the high velocity of the discharge nozzle. A hopper was then devised whereby the intake air was drawn through the bottom of the hopper unrestricted and the dust sifted into the air stream by an agitator similar in plan to a flour sifter. In this way complete control of the dust was had without throttling the ingoing air supply. This hopper was approximately 12 by 12 inches, by 18 inches in height, with a tapered bottom. It was made by a local tinsmith at a cost of \$12.50.

Reelfoot Lake in northwestern Tennessee was selected as a place to work out the details of the dusting equipment. This lake is of earthquake formation with thousands of submerged stumps, the result of a decaying forest. It has large areas of shallow and densely overgrown water, and there are many types of moss, duckweed, lilies, *Myriophyllum*, and other plants. The lake seemed to offer the most difficult conditions under which to operate. Parts of the lake were known to be producing *Anopheles* profusely.

**Tests.**—In order to determine the effectiveness and ascertain the distance of satisfactory killing power of the dust, the following routine procedure was carried out:

First, a check of the density of *Anopheles* larvae in the area to be dusted was made by dipping for approximately an hour, the number of positive and negative dips being recorded.

Second, floating wooden cages 6 inches square made of 1 by 3 inch material, with a bottom of wire screen or cloth, were loaded with known numbers of *Anopheles* larvae and fastened at predetermined distances from the path of dust liberation.

Third, in dusting, measured quantities of dust of



CONDITIONS WHERE USUAL MOSQUITO CONTROL METHODS ARE USELESS

a known Paris green content were liberated uniformly over a given length of a straight path, and the wind carried the dust cloud over the area.

Fourth, after suitable time intervals the dusted area was again checked precisely as before dusting. The mortality in the cages was noted.

**Discussion of Tests.**—Hydrated lime was the principal diluent used. This material was available, it was cheap and comparatively light, and it was thought that it should prove a good vehicle for carrying the Paris green over considerable distances, allowing it to deposit uniformly. The effective area covered was surprisingly large. The Paris green used per acre was between one-half and three-fourths of a pound. With this dosage practically 100 percent destruction of *Anopheles* larvae in the area was obtained. In almost every instance the dust was wind-conveyed beyond the breeding area, but the total effective area covered by the dust cloud could not be determined.

In all of the tests carried out the effective area covered was considered to be that area within which, to all intents and purposes, 100 percent destruction of *Anopheles* larvae was obtained. This destruction was noted as far as 450 feet from point of liberation. The killing distance may be greater; no test was made where breeding extended more than 525 feet from the point of dust liberation.

For the above-mentioned tests, hydrated lime was used with Paris green. The cost of materials used, considering Paris Green at 20 cents per pound and lime at 2 cents per pound, ranged between 16 and 20 cents per acre. When, at wholesale prices, Paris green can be obtained at 17 cents per pound and hydrated lime at \$13 per ton, the cost of materials per acre will be as follows:

One-half to three-fourths pound	
Paris green .....	8½ cents to 13 cents
3 pounds lime .....	2 cents      2 cents
Total cost per acre for materials	10½ cents to 15 cents



DUSTING REELFOOT LAKE WITH PARIS GREEN. IN LEFT PICTURE NOTE THAT DUST CLOUD EXTENDS TO EXTREME RIGHT OF PICTURE

Paris green strengths ranging from 5 to 15 percent by volume were employed. Very satisfactory results were obtained in all instances when lime was used as a carrier with Paris green. There is no doubt that a relation exists between the speed of the boat and distance of effectiveness of destruction of larvae from the boat which may determine the most feasible percentage of Paris green to use. In all experiments the boat speed was between 5 and 6 miles per hour.

**Diluting Dust.**—Aside from lime, only one other diluting dust was tried in combination with Paris green. This was alberene, or soapstone, and the heavy settling of a large part of the mixture close to the path of delivery was disappointing. Although a very heavy volume of dust was liberated, the effective area did not extend over 160 feet from the boat.

It is quite probable that the greater specific gravity of alberene, while an advantage when used in airplane dusting, is not suitable where it is necessary to float the relatively heavy Paris green over an area and hold it in the air as long as possible. With this apparatus the dust is liberated quite close to the water, and quick settling is a disadvantage.

The following weights of materials used at Reelfoot Lake are given for purposes of comparison:

1 pint measure of lime $\text{Ca}(\text{OH})_2$	= 9 ounces
1 pint measure of alberene	= 13 ounces
1 pint measure S. W. Paris green	= 17 to 22 ounces

**Effects of Wind.**—It was observed that gentle steady breezes were most satisfactory for dusting and that stiff or gusty winds tended to make the destruction of *Anopheles* larvae distinctly "spotty" or as though some parts of the water area had not been treated as well as others. In general, a wind velocity of 6 miles per hour or less was found to be the most satisfactory for dusting.

It is believed that the excellent results obtained with this duster are due, in a large measure, to the following factors:

1. Use of a highly toxic Paris green; 2, use of hydrated lime as a diluent; 3, passage of the dust through the impeller whereby it was thoroughly disintegrated, broken up, and mixed; 4, extremely high discharge velocity of the blower, also insuring a well broken up dust.

**Summary.**—This boat duster has shown itself to be especially adaptable to many phases of *Anopheles* larvae destruction work. It can be used economically where no other known method of larval control is feasible. It is easily portable and can be depended upon to dust effectively up to at least 525 feet from the path of liberation. The generator is sufficiently large to operate several blowers of the type described; and as these could be added without entailing additional operators, the entire device is sufficiently flexible to meet almost any condition of possible boat speed.

As already mentioned, this dusting unit consists of a power generator, an electric blower, and a small dust hopper. It was found practicable to load these items into an auto together with the outboard motor and a supply of mixed dust. On arrival at the pond to be treated, these items could be quickly transferred to and installed in the rowboat and made ready for dusting operations. The dusting activity and the guiding of boat were successfully accomplished by one man.

The work at Reelfoot Lake has brought out vividly

a serious defect in the use of Paris green against *Anopheles* larvae that has been reported many times. Paris green varies greatly in its larvicidal power, and in the experiments two of the three kinds used were unsatisfactory. With the increasing use of this larvicide throughout the world, this is a matter of great importance and should be thoroughly investigated in order that Paris green may be purchased under specifications which will assure high toxicity against *Anopheline* larvae. In ordering Paris green as an *Anopheline* larvicide, a sample should be secured before purchase, tested with larvae, and its toxicity demonstrated.

**Conclusions.**—A light, portable power blower has been developed that can be operated by one man, and the whole unit can be set quickly in a small boat. Material costs are as low as 15 cents per acre per dusting. Hydrated lime is the most satisfactory diluent tested for use with Paris green in the power blower, and a mixture of fifteen per cent Paris green gives most uniform results. Moderate breeze velocities, not over 7 or 8 miles per hour, are most satisfactory, and in breezes less than 2 miles per hour the nozzle should be well elevated. In moderate breezes a 15 percent Paris green mixture gives a lethal path at least 525 feet wide. Toxicity for *Anopheles* larvae should be tested for each lot of Paris green.

## Small Septic Tanks and Their Installation

### Features and details necessary for satisfactory tanks for residences, institutions and small communities

Within recent years there has come an increased use by cities and communities of small septic tanks. About 50% of the 1,377 cities, towns and villages covered in a survey by Public Works report the use of small septic tanks in their unsewered sections. The use of this equipment in the suburbs of these communities is probably fully as great.

From the health viewpoint, this marks a very important advance over even five years ago. A similarly important advance is the increasing use of commercial septic tanks, which insures the installation of a tight tank of good design and construction. The home-made tank, which is usually constructed by a local builder, frequently leaks, often lacks depth, and may have other important defects. Also, far more inspection of installation is required for a successful job.

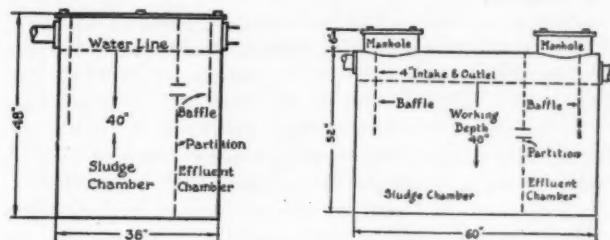
To yield good service, a tank should be tight, have sufficient capacity for the load it has to serve, have ample depth, be properly designed as to intake and outlet, and be properly installed.

Tightness is desirable mainly to prevent leaching out of the sewage, which may contaminate ground water, or may leave insufficient liquid in the tank to carry on the processes of digestion. In some cases, leaky tanks allow ingress of ground or storm waters to such an extent as to flood the entire system.

Differences of opinion exist as to the capacity required for septic tanks serving individual homes, but experience has demonstrated that for the average single family of not more than 6 or 7 people, a 200-gal-

lon tank will give satisfactory service when properly installed. There is, of course, no objection to greater capacity, and many communities require 300 gallons for the average family. Certainly, no tank having a capacity less than 200 gallons should be installed, but if well-designed, a tank of this size will give satisfactory service.

A minimum depth of 30 inches below the flow line has been shown to be necessary for proper operation over a reasonable period of time. A somewhat greater

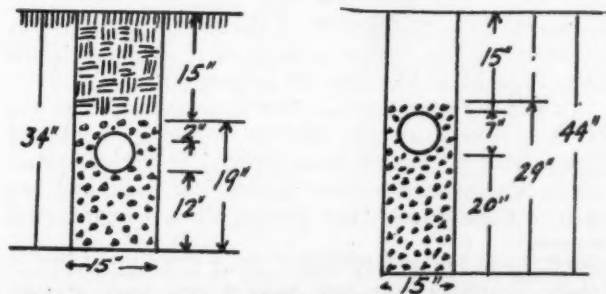


TWO TYPES OF COMMERCIAL TANKS. AT LEFT, 200-GALLON; RIGHT, 500-GALLON

depth, even in small tanks, is an advantage, and 36 inches is recommended as the minimum.

The construction and arrangement of the intake, outlet and baffles are important, and have much to do with the proper functioning of the tank. When, as is frequently the case, the house sewer is laid on a flat grade, or the tank is at the end of a long line, or where the toilet is set to flush only a small amount, the inlet baffle should be quite shallow. In fact, it is better always to limit the depth of the intake baffle to about 8 inches, since, with greater depths, solids are not always carried under it by the flow, and clogging may occur. The outlet baffle should be of moderate depth—12 to 15 inches, and the outlet should be 1 or 2 inches lower than the inlet in order to lessen the chances of water backing up in the house sewer and creating a deadwater area which will slow up the flow from the house and allow the deposition of solids before they reach the tank and consequent stoppage. Careless installation of the tank sometimes results in tipping it backward and creating a dead-water area in the sewer.

Tanks should be so arranged that they can be entered readily for cleaning or inspection. In properly installed tanks which have not been subjected to overloading or abuse, cleaning does not appear to be necessary except at rather long intervals. Tanks in use by the Alabama Power Co., near Birmingham, Ala., which were opened after eight years of uninterrupted use, did not appear to need cleaning. Other tanks in that area, installed about the same time, have not yet shown indication of needing attention.



DIMENSIONS AND SECTION FOR DISPOSAL LINES. LEFT, FOR AVERAGE INSTALLATIONS; RIGHT, FOR LARGER JOBS

Probably small tanks are not as effective in the removal of solids as are municipal installations. At the usual rate of deposition of solid material, tanks should fill with sludge at the rate of about 10 gallons per person per year, but in practice the small tanks do not appear to do so.

The disposal of the effluent is the critical step in most installations of small septic tanks. In most sections of the country, subsurface disposal fields are the method usually adopted for disposal; though in some sections of the East, the effluent from the tank flows into leaching cesspools. Subsurface disposal fields, when properly constructed, provide the most satisfactory method of disposal and, in the end, the cheapest method.

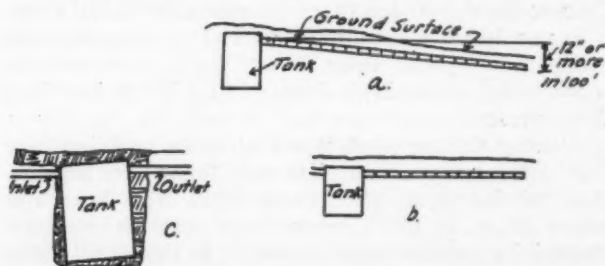
Essentially, this method consists of one or more lines of open joint tile, laid 15 to 18 inches below the surface of the ground. Except where the soil is composed of sand or gravel, some porous material must be placed around the tile.

While in the most favorable soils, almost any construction will be satisfactory for a time, under other conditions the following are essential for proper operation in most cases: Ample length of lines; minimum fall or slope for the lines; an ample supply of porous material.

For an installation to serve the average home under usual conditions, there should be at least 100 feet of disposal line, laid on a slope not exceeding 4 inches per 100 feet. At least 4 yards of gravel, broken stone or other porous material will be required for the construction of the tile line. There should be at least 12 inches of porous material below the tile line.

Ordinary drain tile, bell tile with the lower part of the bell broken off, rapid drain tile, or perforated metal pipes protected against corrosion, may be used for disposal lines. Dimensions and sections for disposal lines for average and for large installations are given in one of the cuts below.

Troubles with small septic tanks that have been properly installed are not numerous. A city health department with supervision over about 4,000 tanks which have been installed at a uniform rate since 1922 kept records of all complaints for a time, listing all important data in connection with each complaint. Though discontinued after about two years because the complaints were relatively few, an analysis of the information recorded showed that practically every complaint was found to have been based on improper construction of the disposal system. This particular city has encouraged installation by licensed plumbers, spending considerable time in teaching them proper methods. While undoubtedly many com-



THREE COMMON CAUSES OF TROUBLE: A. TWO MUCH SLOPE TO DISPOSAL LINE; B. DISPOSAL LINE TOO SHORT; C. TANK TILTED BACK IN INSTALLING, CAUSING DEPOSITS IN INLET AND STOPPAGE. SCALES EXAGGERATED.

plaints went directly to the plumbers and were not registered with the city officials, any widespread difficulty would have been discovered.

One of the largest manufacturers of commercial septic tanks, which has been manufacturing and selling tanks for more than ten years, has kept a careful record of complaints received. These, from all sources, total less than  $2\frac{1}{2}$  per cent of the tanks in use. About 80% of the complaints have to do with faulty installation or inadequate or improperly constructed disposal fields.

## The Reduction in Urban Typhoid

**Water purification and other applications of sanitary science have reduced rates more than ninety percent in the past twenty years**

By James A. Tobey, Dr. P. H.

No deaths from typhoid fever occurred in nine of the largest cities in the United States in 1928. In 16 other cities with populations over 100,000, the death rate was less than 1.0 per 100,000. Of the 81 cities in this population group, more than half, 45 to be exact, showed a typhoid mortality less than 2.0. Only four had rates above 10.0, the highest being 15.0, while the general average of the 81 cities was only 1.89 per 100,000.

Contrast this remarkable record with the conditions of a quarter of a century or so ago. During the period, 1906-1910, seventy-two of the 74 cities then in the 100,000 population class had typhoid death rates in excess of 10.0 and neither of the other two was below 5.0. The general average was 20.58 in 1910, or more than ten times as great as in 1928. The highest rate in 1928 was less than the average in 1911 and about one-fifth of the highest rate of the previous period, 1906-1910.

Few diseases have so thoroughly yielded to the conquests of sanitary science as typhoid fever, particularly urban typhoid. The notable reduction in the mortality from this disease has been due to many factors, including general sanitation, effective sewage disposal, the pasteurization of milk, the control of other foodstuffs and shellfish, the supervision of carriers, and the immunization of a considerable number of persons, but it has been particularly due to the vast improvement in municipal water supplies which has taken place in recent years.

The decline in the prevalence and death rates of some other diseases has likewise been noteworthy, but none compares with the achievement against typhoid. Tuberculosis has decreased in mortality from about 200 per 100,000 population in 1900 to less than 90 today, but typhoid fever in the registration area as a whole has come down from 36 in 1900 to less than 7 at present.

During the past ten years or more typhoid fever has been largely a rural disease. There have been occasional flare-ups in the cities, as in New York and other cities in 1924, when there was an outbreak caused by contaminated oysters. In Montreal there was a severe milk-borne epidemic in 1927 with more than 5,000 cases. On the whole, however, the low urban typhoid incidence remains low and has been

decreasing regularly. It has probably not yet reached its irreducible minimum.

For the last seventeen years, the *Journal* of the American Medical Association has been publishing annual reports on typhoid in the large cities of the United States.\* These reviews contain many valuable and significant facts, and since they are probably seldom seen by engineers and public works officials, a summary of them and a presentation of some of the salient features of these reports may be of interest.

When the first of these articles appeared in 1913, with its description of typhoid death rates for the period 1906-1910 and for the single years 1911 and 1912, the highest rate in any city was that of 65.0 in Pittsburgh for 1906-1910. In the next year, however, this disgraceful rate had been reduced to 25.8 and in the following year to only 12.7. The decline to less than one-fifth of its previous mortality from typhoid was brought about in this city mainly by the installation of a water filtration plant. This community never again had an unduly high typhoid rate and in 1927 was in the honor class with a figure of 1.9 per 100,000, or one-thirty-fourth of what it had formerly been.

Many other cities have displayed similar striking diminutions in the typhoid rate following the construction and use of water filtration plants. Philadelphia is a conspicuous example and in the report for 1926, the American Medical Association stated that, "Philadelphia, a city with distinctly less favorable climatic conditions than New York and presumably with a high legacy of typhoid carriers from the time typhoid ravaged the city, now rivals New York in its low typhoid rate. In Pittsburgh the average typhoid mortality in the years 1906-1910 was nearly twenty-five times as great as the typhoid rate for 1926. The typhoid records in these two cities constitute an outstanding demonstration of the efficacy of water purification."

For many years Cambridge, Mass., was the banner city with respect to typhoid rates. In the period 1906-1910, it had the lowest rate, one of 9.8, and it also had the best record for the period 1906-1920. Though Bridgeport was lowest in 1911, Cambridge led the field from 1912 to 1917, when Chicago took the lead with a rate of 1.7, with Oakland close behind at 1.9, and Cambridge in twelfth place, with 4.4 per 100,000.

Not until 1919 was there any city with a record of zero. In that year Spokane and Yonkers reported no typhoid deaths. Since that time 22 cities have accomplished this enviable feat, one of them, Yonkers, N. Y., on five occasions, and four of them twice. The zero cities are shown in the accompanying table. Excellent as is this record, it does not approach that in Great Britain, where in 1924 there were no deaths from typhoid in 15 of the 48 largest cities.

In looking over this list, it will be noticed that five of these cities in the 100,000 or more population group with no deaths from typhoid at various times are in Massachusetts, three are in New York, and two each in Connecticut, New Jersey, Ohio, Virginia and

\*These articles have been published in the following issues: May 31, 1913; May 9, 1914; April 17, 1915; April 22, 1916; March 17, 1917; March 16, 1918; April 5, 1919; March 6, 1920; March 26, 1921; March 25, 1922; March 10, 1923; Feb. 2, 1924; March 14, 1925; March 27, 1926; April 9, 1927; and May 19, 1928.

TABLE 1

Cities Having No Deaths From Typhoid

Yonkers, 1919, 1922, 1926, 1927, 1928	Hartford, 1924
Lowell, 1925, 1928	Scranton, 1925
Youngstown, 1926, 1928	Albany, 1926
New Haven, 1927, 1928	Utica, 1926
Springfield, Mass., 1927, 1928	Canton, 1927
Spokane, 1919	Kansas City, Kan., 1927
New Bedford, 1922	Paterson, 1927
Providence, 1922	Richmond, 1927
Norfolk, 1923	Duluth, 1928
Fall River, 1924	Elizabeth, 1928
	Lynn, 1928
	Tacoma, 1928

Washington. Since 1924 the data on these large cities has been arranged in the reports according to the geographical sections of the United States. Invariably the northern parts of the country, particularly the New England States, have shown excellent records, while the south central states have had the poorest.

The following table, taken directly from the American Medical Association report for 1928, shows this data:

TABLE 2

Total Typhoid Death Rate per Hundred Thousand Population in Eighty-one Cities According to Geographic Divisions

		—1928—		—1927—		1926	1925
	Popula- tion	Ty- phoid Deaths	phoid Rate	Ty- phoid Deaths	phoid Rate	phoid Rate	phoid Rate
New England	2,548,088	23	0.90	32	1.26	1.51	2.37
Middle Atlantic	11,790,733	177	1.50	166	1.41	2.09	2.97
South Atlantic	2,285,300	85	3.72	76	3.39	5.38	5.71*
East North Central	8,512,300	94	1.10	109	1.31	1.69	2.19
East South Central	881,600	68	7.68	86	10.07	14.47	14.30
West North Central	2,602,800	43	1.65	47	1.86	2.22	3.31
West South Central	1,764,200	109	6.18	114	6.71	11.69	13.27†
Mountain and Pacific	3,750,263	72	1.92	61	1.74	1.98	2.19

\*Lacks data for Jacksonville.

†Lacks data for Oklahoma City.

Having outlined some of the good records, it may not be amiss to mention some of the worst. Since 1906 Nashville has had the highest typhoid death rate in seven of the reports, has had the second highest in 4, and the third highest in 3. Memphis has been high 5 times, next to the highest 6 more, and third twice. Birmingham has been high twice, in second place 3 times, and third on 4 occasions, but since 1920, when a full time health officer took charge, it has had consistently one of the lowest typhoid death rates in the south. Other cities which have had the worst records in one year only are Atlanta, Paterson, Pittsburgh, Reading, and San Antonio. Other cities frequently listed in the lowest group have been Grand Rapids, Dallas, and New Orleans. Some of these have made good records at times, but Nashville and Memphis never have done so, except in 1920, when they reached 9.8 and 7.9, respectively. That shows what could be accomplished.

The cities with the worst rates are shown by years in the following table:

TABLE 3

Typhoid Death Rates per 100,000 Population			
1906-1910	Pittsburgh . 65.0	1920	Paterson .. 14.7
1911	Memphis .. 61.2	1921	Nashville .. 20.4
1912	Memphis .. 56.2	1922	Nashville .. 16.2
1913	Reading ... 58.0	1923	Atlanta .. 17.1
1914	Nashville .. 47.3	1924	Memphis .. 41.2
1915	Nashville .. 35.1	1925	Memphis .. 28.6
1916	Birmingham 42.6	1926	Nashville .. 35.0
1917	Birmingham 54.1	1927	Nashville .. 16.0
1918	San Antonio 54.3	1928	Nashville .. 15.0
1919	Memphis .. 58.4		

If the typhoid fever death rate of 1910 still prevailed, there would have been more than ten times as many deaths from this disease in 74 of our largest

cities than actually occurred in 1928. In other words, the reduction in urban typhoid in this country resulted in an actual saving of approximately 6,200 human lives in a population of more than 33,000,000, located in cities in the United States. This is a real triumph. At least these 6,200 living individuals would think so, if they knew just who had been saved.

The decline in the total typhoid rate can be shown in the following table, taken directly from the American Medical Association report for 1928.

TABLE 4

Total Typhoid Rate for Seventy-four Cities, 1910-1928\*

	Population	Typhoid Deaths	Typhoid Death Rate per 100,000
1910	22,286,000	4,586	20.58
1911	22,916,700	3,883	16.94
1912	23,535,450	3,077	13.07
1913	24,151,936	3,222	13.34
1914	24,776,777	2,744	11.07
1915	25,392,422	2,373	9.34
1916	25,928,745	2,154	8.31
1917	26,528,213	1,936	7.40
1918	26,737,190†	1,796†	6.72
1919	27,373,579†	1,141†	4.17
1920	28,182,528	1,074	3.81
1921	28,509,732	1,130	3.96
1922	28,947,007	955	3.30
1923	29,580,000	936	3.16
1924	30,155,014	937	3.11
1925	30,938,501	1,067	3.45
1926	31,667,424	895	2.83
1927	32,492,123	638	1.96
1928	33,116,784	627	1.89

The control of typhoid fever, as in the case of any disease, is a good business proposition. If the value of human life can be figured at \$9,333 at birth, as has been computed by leading statisticians, then at least \$57,864,600 was saved to the nation in one year by the reduction in urban typhoid. This is, furthermore, a conservative figure, for deaths from typhoid take place at all ages and a person's economic value increases with age. It would seem, therefore, that money appropriated by municipalities for water purification is not only a humanitarian matter of great importance, but also an extremely good business investment.

\*The following seven cities are omitted because data for the full period are not available: Canton, Dallas, Jacksonville, Oklahoma City, Tulsa, Utica, Wilmington.

†Lacks data for Fort Worth.

### Water Waste Survey of Waltham, Mass.

A water waste survey of the water works system of Waltham, Mass., made last year by the Pitometer Company, revealed an underground leakage of 12.5% of the average daily consumption of 2,180,000 gallons. The total domestic, commercial, and public use was 1,411,000 gallons, or 38.8 gallons per capita. One of the principal sources of waste was in unmetered fire lines.

The ratio of night rate to 24-hour rate was determined by districts. In the one district mainly residential, the night rate was 67% of the daily average. In two that were residential and commercial it was 61% and 67% respectively. In the three that were combined residential, commercial and industrial it was 60%, 70% and 56% respectively; although the 70% had been reduced to 50% three months later. About nine per cent of the water was wasted by overflow from the standpipe.



# Improving Water Works System of Scotia, New York

Ground water supply increased by substituting pumps of greater efficiency set at a lower elevation. Cost reduced by off-peak pumping. Laying mains under railroad tracks

By Henry W. Taylor

About twenty-five years ago the village of Scotia, New York, installed six 8-inch tubular wells, a small pumping station, a 100,000-gallon elevated storage tank, and distribution piping, as its original water supply system. With the growth in population, the capacity of the storage tank has become inadequate and there has been difficulty in pumping sufficient water from the wells. The latter was taken to represent a water shortage and the problem of meeting the situation has been on the minds of the city officials for several years.

Prior to the writer's connection with the project, an investigation was made to determine the feasibility of a gravity system from a new source, discarding the existing well supply. This project would have required a long conduit leading to a questionable source of supply, at a cost of about \$400,000, and satisfying this community with a warm, surface water, with filtration and probably chlorination, after it had become accustomed to a cold, uniformly clear, well water, which it regarded as the best supply in the state of New York as to color, safety and taste. The well water has an average bacterial count of from 3 to 5, and as far as quality is concerned would be beyond duplication. In view of the cost of changing from a supply giving complete satisfaction to one of questionable characteristics, it was recommended that the possibilities of the existing supply be thoroughly studied.

The only factor requiring investigation was that of quantity. The first pumping installation, which was added to after the same manner in later years, consisted of a centrifugal pump set some eight feet above the high water level in the wells, and connected with the wells by a long suction header. The lift limitation of such a pumping layout is evident, and with the seasonal variation in the water table, difficulty in pumping the water was experienced yearly. The public, however, considered the difficulty to be a lack of water, rather than inability to utilize the water available.

Existence of a similar type of water supply, which has proved successful for years, viz., Schenectady (across the Mohawk river from Scotia), suggested that an investigation would prove a similar reliability for the Scotia source of supply, and the availability of sufficient water if the pumping equipment be adapted to the situation. A test pump was purchased of the deep-well type, and lowered into one of the wells for experimental purposes. Copper tubes carrying air pressure gauges were installed in all the well cases, and the differentials in water level under different conditions were determined by the use of an air pump which registered less pressure as the reacting depth of water decreased. Tests were also made of the efficiencies of the existing pumping units, and eleva-

tions were taken (referred to the U.S.G.S. datum) of the surrounding territory, water levels, etc.

These preliminary levels proved to be of primary interest, and the principal elevations are tabulated below:

Elevation at high point in village, about.....	280.0
Elevation of grade at pumping station and well area .....	260.0
Top of well casings.....	244.5
Elevation pump room floor and floor of suction header conduit .....	242.5
High water in wells (in Spring).....	240.0
Low water in wells as of February, 1929.....	233.1
Mohawk river, below Scotia (with flashboards up) .....	213.0
Mohawk river, below Scotia (with ashboards up) .....	213.0
Bottom of well casings, probably about.....	205.0

These elevations indicated that the Scotia supply has a characteristic distinct from the Schenectady supply, in that it is independent of river stages. In the case of Schenectady, the river acts as a backwater to the well water flowing toward it, and the well water level is disturbed by river stages. The Scotia well area is about two miles from the river and is well above it even at low stage of water table.

Tests of the efficiency of the present pumping units showed pump efficiencies of from 50 to 60 percent, while equipment of later design will yield 80 percent. The long suction header and the large suction lift were probably factors in these low efficiencies. The tests were sufficient to warrant the purchase of new apparatus in connection with the new project.

A large number of experiments were made, with and without the use of the test pump, to study the action of the well water under different conditions. Instead of a complete statement of the work done, there is given below a general statement of the case, with an illustration of the methods used. The result of the work warranted the opinion that the present source of supply was adequate for at least two million gallons per day, the amount considered for the gravity supply. No attempt was made to state the ultimate capacity of this source, but the writer's opinion is that the well area will prove itself adequate for a much larger quantity than two million gallons. It is estimated that the demand of Scotia for two million gallons per day will not materialize until 1960. In the meantime, the further capacity of the well area can be studied at leisure and additional development undertaken, if warranted.

Well No. 1 was pumped by the test pump, and being at the end of the well header system was found to be badly clogged and of a less capacity at 20 feet loss of head in the well than other wells indicated at two or three feet head loss. Attempts to blow this well with water and air did not give satisfactory results, and it was decided that the twenty-five-year old strainer was clogged beyond relief. It was not prac-

ticable to shift the testing unit to another well, and the other wells were pumped with the existing pumping apparatus under suction lift, simultaneously with the test pump, and various combinations of well pumpage gave the results upon which conclusions were based.

It was found that, though the wells were only from 30 to 45 feet apart, it was impossible to deflect the ground water table on a curvature which would be registered at an adjacent well when the well next to it was being pumped. In other words, losses in each well were confined within very close range of the well itself and were no doubt in a large percentage purely strainer and pipe losses. On the other hand, it was found that there was a very close hydraulic connection between the wells through the coarse underground medium. For example, the head was removed from well No. 2 while well No. 1 (where the test pump was located) was being pumped. When the test pump was started, the water surface in well No. 2 experienced an instantaneous reaction corresponding to a water hammer, and the same reaction took place on stopping the test pump; but at no time was there any measurable change in the elevation of the water surface in well No. 2. An attempt was made to locate a directional flow in the well area, but the available pump capacities were not sufficient to make a definite determination measurable, though the suggestion was obtained that the flow probably came from the west, while at the same time one was forced to believe that there was a considerable underground reservoir in the well area which acted as underground storage and did not produce an appreciable flow velocity from any direction. A study of the underlying geological conditions also suggested a flow from a western area along the Hudson rock which extends as far west as Oneida Lake and also in a northerly direction toward the upper reaches of the Hudson river.

The accompanying plates illustrate the action of the wells under two conditions which are representative of the average experiment. Well No. 1 was pumped to a capacity of 284 gallons per minute and to a depth of about 20 feet. Wells Nos. 3, 4, 5 and 6 were pumped with the existing suction lift pump and together yielded 840 gallons per minute. The loss in well No. 1 was about 20 feet, while the losses in other wells averaged about 2.5 feet; the total flow was 1,124 gallons per minute, and if pumping capacity had been available, this total could apparently have been largely increased. It will be noted that well No. 2 was used for observation and no deflection of water surface was measurable, although wells on either side of it were delivering water. In case of the second chart, it will

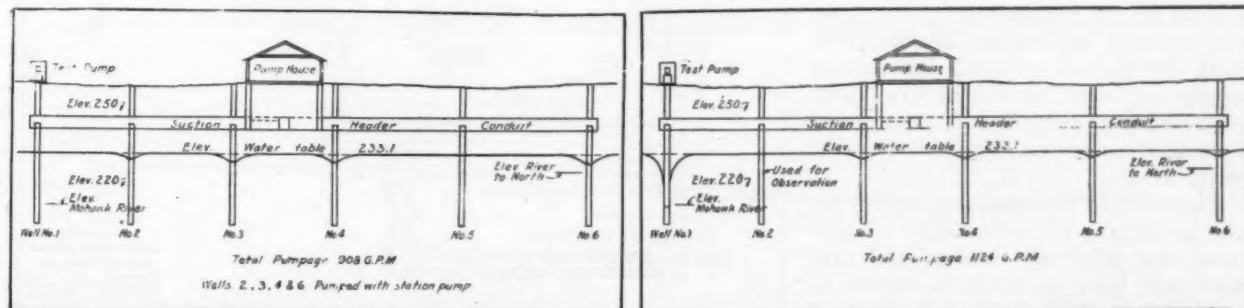
be noted that well No. 5 was used for observation, and neither wells No. 1 nor No. 5 showed any effects from pumping adjacent wells.

The yield of the area to proper pumping equipment was apparent and experiments indicated that the entire quantity of water desired could be obtained from one well with proper infiltration capacity. The intermittent pumping practiced for the last twenty-five years has proved that there still remains about 30 feet of water which has never been used. A seasonal variation of water table is, of course, expected, as well as an increased flow to the area when apparatus is installed to depress the water table to a lower depth than is now possible. Intermittent pumpage also is considered to probably entail a loss due to some degree of flow past the area when the pumps are not in operation.

From a mechanical point of view, the very apparent need of the Scotia system was the installation of a vertical-type pump which could be lowered to a point of submergence of at least 20 feet in the available underground storage and be in a position to deliver its capacity under any condition of the water table. It was consequently decided to install low-lift pumps of the vertical type, these pumps to discharge into a low-level reservoir which would hold a sufficient amount of water to permit of pumpage from the ground at a more or less uniform rate, and possibly on a twenty-four hour basis; while the high-duty pumping could be done intermittently and on off-peak periods of the local power company.

The other crying need of the Scotia water system was additional storage capacity. With the present equipment it is necessary to pump every other hour for about 50 minutes in order to maintain storage in the 100,000-gallon tank and good pressures for all locations. This involves pumping the wells intermittently and at over twice the average rate, thereby introducing unnecessary well losses and introducing the element of loss of water due to flowage by the well area when pumping is discontinued. The new storage reservoir also provides a safeguard against power breakdown, allows time for mechanical adjustments, and provides a storage into which the daily supply can be discharged with only a few hours of off-peak pumping. This off-peak pumping will materially affect the power rate and consequently the operating cost of the system.

Contract has recently been let for the execution of the proposed work, which may be described as follows: A new open well, 10 feet by 15 feet in area, and about 30 feet deep, below the level of the pump room and 45 feet deep below natural grade, is to be installed



DIAGRAMS ILLUSTRATING ACTION OF WELL UNDER TWO REPRESENTATIVE CONDITIONS

with steel sheeting and structural steel frame braces. It was considered that this open structure, with a bottom infiltration area of 150 square feet, would, for Scotia conditions, be more effective than multiple cased wells. In this well will be installed three vertical-shaft rotary pumps of capacities of 400, 600 and 800 gpm. The discharge of these pumps will be received in a low-level reservoir adjacent to the pump room. The new pumping station, adjacent to the existing structure, will have its operating floor about 16 feet below natural grade. The roof of the open well is at the level of the new pump room floor, and the floor of the low-level reservoir is at this same level and provides for 15 feet depth of water, which supplies positive suction to the high-duty pumps. The variation in size of well pump was provided so that there would be afforded an opportunity to pump the wells at various rates with varying continuity, as experience might prove to be most advantageous; with the arrangement to be installed, a well pumping capacity of 400, 600, 800, 1,000, 1,200, 1,400 and 1,800 gpm. can be arranged for.

The accompanying cut shows the roof of the well in plan with the three low-duty pumps installed on it, while on the other side of the room are located three high-duty pumping units, with an area reserved for a fourth unit if occasion demands. Two high-duty pumping units are single-stage centrifugal pumps of 2,000,000 gallons capacity to operate against a total head of 210 feet. The third pump is of 600 gallons capacity and will be used in conjunction with either one of the 2,000,000-gallon units to supplement it as consumption increases.

All pumping equipment is designed to operate both automatically and with manual control. The deep-well pumps will ordinarily be controlled by float relays. When the low-level storage area is full, all low-duty pumps will be stopped automatically, and as this water drops due to the consumption of the high-duty pumps, the floats will be arranged so that they will come into operation in series as the water level is lowered.

The high-duty pumps will be started manually and will be stopped by electric clock relay. The off-peak period for power starts about nine o'clock in the evening and extends to six in the morning, and the pumps will be started at nine o'clock by the station operator and the clock relay will shut the motors down at any predetermined time, prior to six in the morning.

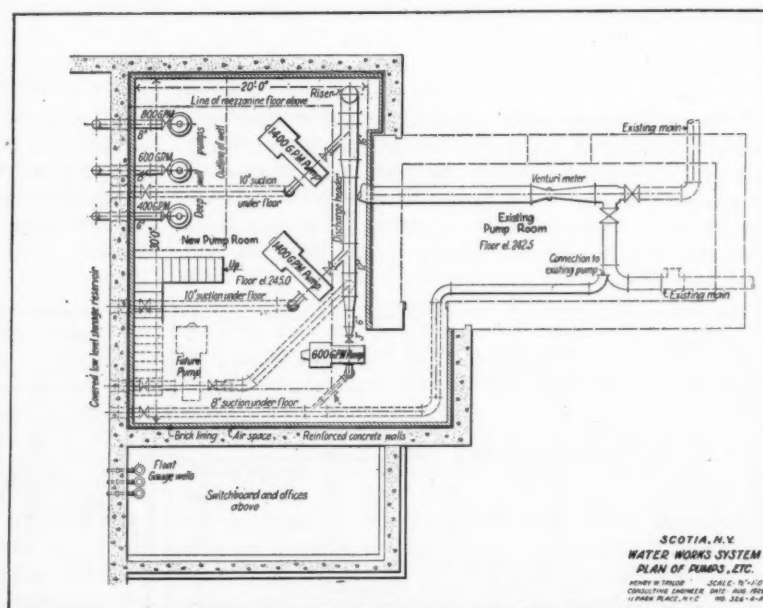
The pump room floor is a double floor construction, the structural floor being underneath all suction piping, conduits, and auxiliary apparatus. The depth of about 14 inches required for suction piping and conduits will be filled with gravel after testing of this piping and a finished concrete floor laid over the entire area.

The walls of the pumping station below grade are to be installed of concrete, and after all conduit and pipe work has been installed, a veneer of pressed brick is to be laid in front of the concrete walls, with air space

between, to provide satisfactory finish without rubbing, to conceal cuttings and auxiliary piping and conduits, and eliminate all dampness in the pump room itself. Around the pump room proper, and at the ground floor level, a cantilevered mezzanine floor will be installed which gives access to the switchboard, the office and to grade. The superstructure of the existing pump house will be removed, and the existing ground level floor be converted into a vault roof, while the basement of the existing pump house will be used for its present piping connections for a station heating plant, and an existing gasoline-driven pumping unit.

This new pumping layout obviates the main trouble experienced with the present system, namely, that of getting and maintaining negative pressures in suction headers and pumps, since all pumping equipment is hydraulically submerged and is subject to automatic operation without priming.

The only available location for a concrete reservoir proved to be on the low hills to the north of Scotia and on the opposite side of the main line tracks of the New York Central and Hudson River Railroad. This location involves extending the force main under the New York Central and Hudson River Railroad. The expense of track storage, in the case of the New York Central, would be over \$8,000, and consideration was given to an overhead crossing over the new grade crossing elimination structure. This also proved complicated and it was finally decided to install an enclosing conduit approximately as shown on the drawing. The concrete conduit will be installed in open cut under the trolley line tracks and up to a point outside the slope line from the steam tracks. For the remainder of the distance the concrete pipe will be jacked through the railroad subgrade. A laborer excavates a distance of about one foot in front of the pipe and the pipe is then jacked ahead, and the operation repeated. About one hour can be installed by this method and without disturbance to the subgrade. A double line of pipe will be installed in this enclosing conduit, and in



PLAN OF WELL SHOWING LOCATION OF PUMPS

SCOTIA, N.Y.  
WATER WORKS SYSTEM  
PLAN OF PUMPS, ETC.  
DESIGNED BY THOMAS J. CONNELLEY  
CONSULTING ENGINEER, 1100 N. 10TH ST.  
PITTSBURGH, PA. 15224

case of leakage and repair, either line can be cut off while the other remains in service alone for a short period. The two 12-inch pipes will not be hydraulically equal to the sixteen, but the increase in head loss for this short distance will not be sufficient to warrant the handling of heavier pipe in the close quarters of the conduit.

The total cost of the work, as now under contract, will be less than \$140,000. The new apparatus will reduce the present operating charges by about \$5,000 per year and this saving will pay most of the interest on the new expenditure. At the above cost, the village gains a water supply of unusual quality, and adequate for the next thirty years at least and probably capable of further development.

### Inspecting Mineral Aggregates

Methods of inspecting mineral aggregates were discussed by A. S. Rea, in a paper before the annual meeting of the A. S. T. M., under the heads of preliminary investigations, inspection during construction, methods of sampling and field tests. The first includes detailed description of each deposit or quarry, name of owner, geological formation, amount and character of overburden, approximate quantity available, and whether material from this source has been used previously, where, for what purpose and with what results; also shipping facilities and plant equipment, if any.

Inspection during construction may be at either source or destination or both. Inspection at destination only is aided by the adoption of acceptable field tests.

For sampling, the "Tentative Standard" method of the Am. Ass'n of State Highway Officials is recommended.

The most important field tests of aggregates are the screen test, silt test, colorimetric test for sand and weight per cubic foot. The first is the one in most general use—in many cases the only one ordinarily required. The most accurate and satisfactory silt test is by weighing the dried sand before and

after washing out the silt. The colorimetric test consists in adding a 3% solution of sodium hydroxide to a given volume of sand in a graduated bottle; if after 24 hours the liquid has only a slight yellow color, the sand is satisfactorily free of organic impurities. Weight per cubic foot may be a specification requirement for blast furnace slag and other coarse aggregate.

## Denver Water Conduit Extension

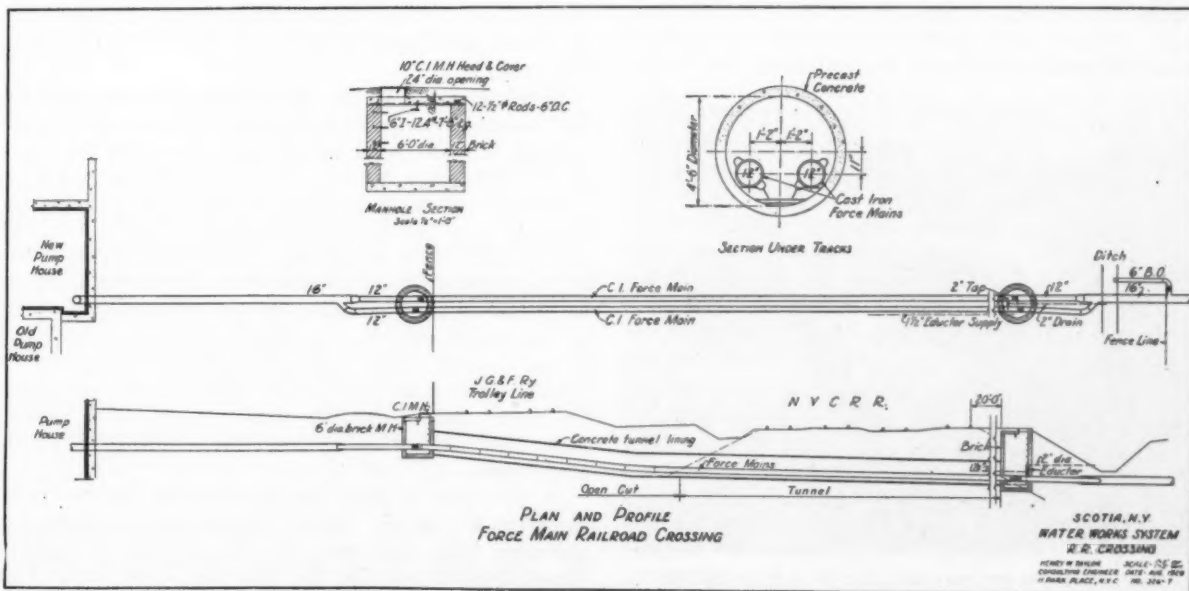
Interesting methods used in laying 60-inch reinforced concrete pipe

By Jos. C. Coyle

The water supply of Denver, Colorado, is taken from the Platte river and its tributaries, which have a drainage area of 39,010 square miles, lying partly in a region of perpetual snow and partly in the arid foothills of the Rocky Mountain range. The first pipe line of the system, laid in 1871 when the city had a population of only 5,000, is still partly in use. Now the system, which is valued at \$23,000,000, includes hundreds of miles of pipe and conduits. The larger conduits are largely of wood staves, though the later tendency is toward reinforced concrete construction.

The latest of these, a 60-inch reinforced concrete extension of conduit No. 10, extending eight miles from Wynetka Junction to the Capitol Hill pumping station, is nearing completion by the Lock Joint Pipe Company, of Ampere, New Jersey. A complete plant for manufacturing the pipe, each 12-foot section of which weighs 7 tons, was erected temporarily near the line.

Two Northwest pull shovels and one 25-ton steam crane (American Hoist & Derrick Company) were used by the two pipe line crews. With the pull shovel excavating and the crane placing pipe and backfilling with a heavy steel drag after the regular shift had quit, one crew made as high as 300 feet of line per day. The ditch averaged 8 feet wide and from 9½ to 15 feet deep. Surplus dirt was loaded directly into trucks by the shovels, and hauled away. Uneven spots



METHOD OF CROSSING UNDER RAILROAD



LOADING PIPE ONTO TRUCK

in backfilling were smoothed out with a Blair Hydraulic Digger, equipped with a Fordson motor. Considerable rock was encountered in spots, particularly at the two railroad undercrossings and the crossing of the Platte river near Littleton. Several low spots also brought trouble from caving, due to seepage.

The crossing of the Platte river was accomplished in three sets, interlocking steel piling being driven to form a cofferdam around an area 18 feet wide and 103 feet long at each set. The piling was braced with a frame of 14"x14" timbers. One of the Northwest shovels was equipped with a boom and clam shell for removing the gravel within the cofferdam to a depth of about 10 feet. The trench was then blasted out 7 feet deep in the blue shale bedrock for the pipe. Drilling was done with air drills, and the banks were trimmed down with two 10-C C-35 Ingersoll-Rand paving breakers. Two portable compressors of the same make were used on the job for the drills and in driving piling with a Burney-Carey No. 6 hammer. A set was made on each bank of the river and another in mid-stream, the water being diverted to one side while work was under way on the middle set. Naturally a considerable amount of water was encountered in the excavation, and two C. H. & E. gasoline pumps and a 6-inch open runner centrifugal pump (name unknown) were used to remove it.



PLACING PIPE IN TRENCH AT PLATTE RIVER CROSSING  
Showing wheel used for tightening joint.

Pipes were placed in the trench with the Northwest, and the joints tightened up by means of a chain, one end of which was attached to an expanding bar inside the pipe line, and the other end to a tension wheel at the end of the last length. The sections were suspended on a wire cable, secured to the top of the piling, until the joints were completed and concrete poured around them, being brought up to a point 18 inches over the top of the pipe. All pipe was laid on a cushion of 2 inches or more of screened sand, to prevent possible damage to the exterior from sharp rocks or other projections on the trench bottom.

The crossing of the Santa Fe and the Denver & Rio Grande Western Railroad tracks was very much simplified by taking advantage of concrete culverts, where the two roads ran parallel and near together, as well as the culvert under the Denver-Colorado Springs highway, which also was near by. Most of the excavation at this point was in solid blue sandstone. The little loose material on top was removed with the Northwest and 8 feet of rock drilled and blasted. Round of 6 holes were drilled at an angle of about 45 degrees toward the excavation, requiring about an hour to the round, with two drills. Two lifts, with holes loaded lightly with 40% dynamite,



"SQUEEZING THROUGH" THE SANTA FE CROSSING WITH A SECTION OF PIPE

were used under the culverts, to avoid damage to the structures. Air was furnished through a 2-inch pipe line from an Ingersoll-Rand portable compressor on the bank.

Surplus water in the excavation was pumped out and diverted along the trench bank in a ditch, supplemented in spots with 8-inch iron pipe. In the Santa Fe culvert there was barely room for the shovel to creep through with its loads of dirt and with the sections of pipe, which it placed in the trench. This section of pipe line, under and for 40 feet on each side of the railroads, was covered with 6 inches of concrete, to guard against possible erosion from future floods in the small ravine. In other sections of the ditch where considerable rock was encountered, it was usually broken up with Ingersoll-Rand paving breakers and removed by the steam crane, in a wooden skip. Air diggers were used in trimming down the clay banks.

D. D. Gross is chief engineer for the Denver water department. H. R. Oliver is engineer in charge of the pipe line work and W. W. Trickey is general superintendent of the job for the Lock Joint Pipe Company.

# PUBLIC WORKS

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## CONTENTS

CONSTRUCTION OF WANAQUE AQUEDUCT. Illustrated. By A. A. Jones.....	331
TRADE WASTE PROBLEM IN NEW JERSEY.....	335
SEWAGE TREATMENT AT BIRMINGHAM, ENGLAND. Illustrated.....	337
CONSTRUCTING PARDEE DAM. Illustrated. By James N. Hatch.....	340
Liquid Chlorine Injunction Extended.....	344
Preparing for Street Improvements.....	344
CONCRETE ROAD PLANTS.....	344
STATE ROAD CONSTRUCTED NEAR LIBERTY, N. Y. Illustrated.....	346
BERGEN COUNTY, NEW JERSEY, HIGHWAYS. Illustrated. By Lester H. Burns.....	347
UTILIZING ROCK FROM HUDSON RIVER BRIDGE CONSTRUCTION. Illustrated.....	349
Prequalification of Contractors Favored by Western Highway Officials.....	350
BUILDING COLD ASPHALT EMULSION ROAD IN CANADA. Illustrated.....	350
An Eight-foot Sewer "Pill." Illustrated.....	351
APPLYING PARIS GREEN AS AN ANOPHELINE LARVICIDE. Illustrated. By J. A. Le Prince and H. A. Johnson.....	352
SMALL SEPTIC TANKS AND THEIR INSTALLATION. Illustrated.....	354
THE REDUCTION IN URBAN TYPHOID. By James A. Tobey.....	356
Water Waste Survey of Waltham, Mass.....	357
IMPROVING WATER WORKS SYSTEM OF SCOTIA. Illustrated. By Henry W. Taylor...	358
Inspecting Mineral Aggregates.....	361
DENVER WATER CONDUIT EXTENSION. Illustrated. By Jos. C. Coyle.....	361
EDITORIAL NOTES.....	363
Water Purification and Typhoid Reduction—	
New Problems in Public Health—The Problem of Trade Wastes.	
Launching Detroit River Tunnel. Illustrated.....	364
SNOW HANDLING MACHINERY. Illustrated.....	365
RECENT LEGAL DECISIONS.....	367

## Water Purification and Typhoid Reduction

In this issue, in which much space is devoted to a discussion of water works matters in connection with the annual convention of the New England Water Works Association, there appears an especially timely and important article on typhoid fever reduction. It should be of unusual interest to water works men because there is almost unanimous agreement that the greatest factor in this great accomplishment is pure water supplies. The author states that, as a cold money proposition, typhoid reduction saves more than fifty-seven millions of dollars each year, and that money expended for water purification, in addition to being a humanitarian matter of great importance, is therefore an extremely good business investment also.

This fact, which is undisputed, brings to mind the large number of smaller communities which are without adequate, or any, water supplies. Bringing pure water to these communities entails a chain of improvements which cannot help but affect most favorably the life of that community. Pure water increases health protection; an adequate, well-planned supply reduces fire insurance rates greatly; running water in the home increases property values; sewerage systems naturally follow, and typhoid rates take another fall. Water works cost money, but lowered death rates, decreased insurance rates, and increased property values more than compensate in many or all cases. And not only is typhoid affected, but a number of other kindred diseases pass out when conditions favoring typhoid are eliminated.

A systematic campaign by a state board of health to induce smaller communities to put in adequately designed and properly operated water supply systems would not only benefit greatly the communities themselves, but probably would have a marked effect upon the typhoid rate of the rest of the state.

## New Problems in Public Health

Modern transportation facilities continually present new problems in public health. The question of roadside water supplies is not new today, nor the sanitation of tourist camps and gasoline stations, though these are somewhat more recent. Perhaps the latest worry of the rural sanitarian is the inclination of roadside stands and gasoline stations to serve food. Control of food handlers and food products under such conditions is exceptionally difficult, not only because of the general ignorance and lack of desire of operators of such places to observe sanitary laws, but also because in most rural areas there are no laws that can be applied to the control of food handlers and food products.

Another problem that most states and counties have honored more by neglect than by attention is that of summer resorts. Perhaps health departments are not to be blamed for their general desire to excuse their neglect of these problems by the fact that most of the laws applying to rural boarding houses are not, in fact, health laws, but nuisance laws, and that constructive and sound health work is not possible, as a rule, under these laws. Nevertheless, the problem is a serious one and demands attention. We would like to see an able and effective health organization, such as that of New York

State, attempt the regulation of these places. If nothing real were accomplished, such an effort would at least point out the loopholes in our present health codes and the necessity for revisions to cover this subject.

No one who has any real knowledge of the conditions now existing in such summer resort areas as Sullivan County, in the southern Catskill region of new York State, will attempt to minimize the need of effective sanitary engineering among the many thousands of summer boarding houses there. There are undoubtedly many other areas as bad in neighboring states. Proper sewage disposal and safe water supplies are as necessary for these summer visitors as for anyone else, but in a great number of cases neither is provided. There is cause for wonder why no progressive and determined step has been made by state or local health authorities in such sections.

### The Problem of Trade Wastes

Twenty-five years ago it seemed to be assumed that prevention of stream pollution was almost wholly a matter of sewage purification, and that sewage contained (besides water) chiefly excrement and domestic wastes. Treatment methods, including efforts to utilize sludge as fertilizing material, were based largely on this assumption.

This assumption failed to recognize the importance of the trade wastes which even then were an important factor; and since then the amounts of such wastes have increased greatly. As stated in an article on page 336 of this issue, nearly half of the organic pollution of the Raritan river is caused by trade wastes. It was estimated a few years ago that the industrial wastes of Chicago were equivalent to the domestic wastes from a population of 1,500,000 people.

The Passaic Valley sewer, begun twenty-five years ago to remove from the filthy Passaic river all sewage entering it below Paterson, is now in use, but while the odors and paint-destroying sulphurous gases formerly arising from it are no longer so evident, the water still looks almost as dark as ever and fishing in it would be an absurdity; and this result will not greatly improve until the wastes from industries in Paterson and below are excluded from the river.

The waste problem is one not only of how but also of who. Should the expense of evolving methods as well as of installing and operating plants for

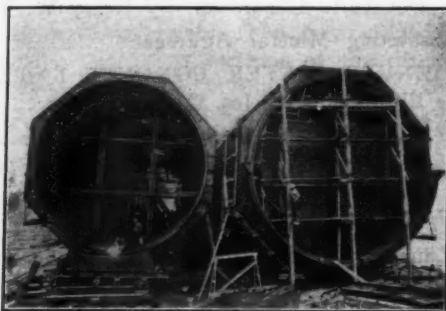
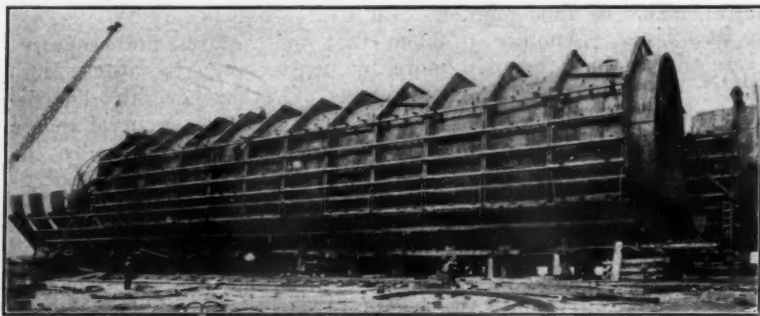
treating industrial wastes be borne by the industries or by the tax payers? This question is discussed in the paper referred to above.

## Launching Detroit River Tunnel

The new vehicular tunnel which will run under the Detroit river between Detroit, Mich., and Windsor, Canada, is being built in sections which are constructed above water, are floated to place and sunk into position at the bottom of the river, where they are connected up into a continuous tunnel. This method of constructing subaqueous tunnels is by no means new, the Estuary tunnel between Oakland and Alameda, Cal., having been constructed in this way, as described in our issue of October, 1926; while in 1907 a tunnel 2600 feet long was sunk in this way in the Detroit river to form a tunnel 23 feet in diameter.

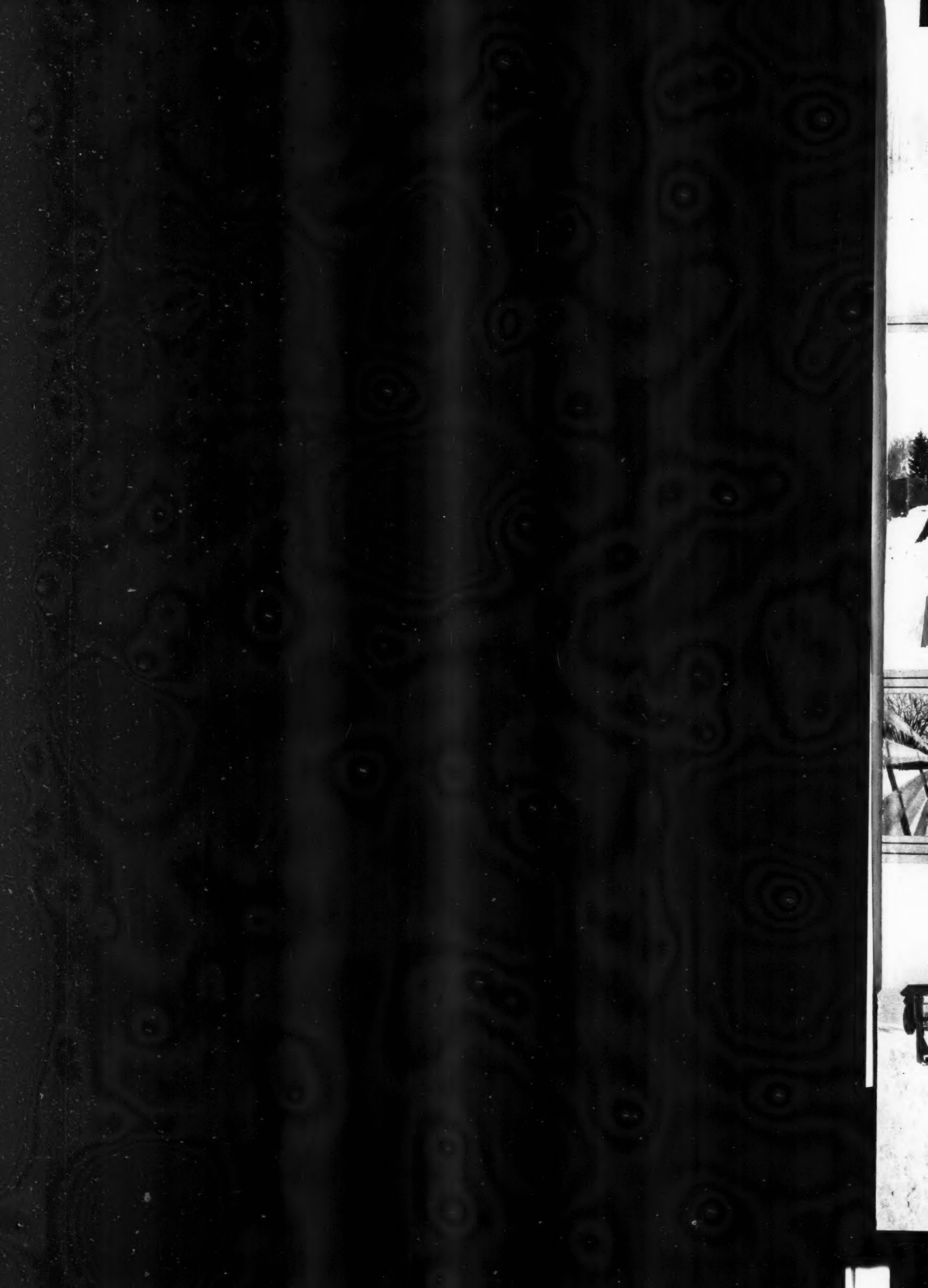
The new Detroit river tunnel will have an inside diameter of 31 feet and an outside diameter of 35 feet. The roadway will be 22 feet wide, and will give a clearance of more than 14 feet overhead. Each section is 250 feet long, and is built up of 24-foot strips of steel plate electrically welded together with General Electric welding machines. This construction work is being carried on by the Canadian Bridge Company, at Ojibway, Canada, six miles down the river from the site of the tunnel. After each section has been made, the joints are tested for water tightness, bulkheads are placed at each end of the section, and it is then launched and towed to the dock, where the steel is covered both inside and out with about 4200 cubic yards of concrete. The section, now weighing approximately 8000 tons, is towed up the river to the tunnel site and sunk into the trench in the river bed which has been dredged out for it. On August 1st, four of these sections had been set in place and it was expected that most of the remaining sections would be in place before cold weather comes.

There will be approximately half a mile of this subaqueous tunnel, and about a quarter mile of approaches. The latter are being bored by the largest shield ever used in North America. The Detroit approach was completed this summer and the shield transferred to the Canadian side, where it is now working on the approach at that end. This shield is 35 feet in diameter and 15 feet long. It is pushed forward by hydraulic jacks, 30 inches at a time. The concrete lining is begun as soon as the shield has moved far enough forward to allow room for the 25-foot form.



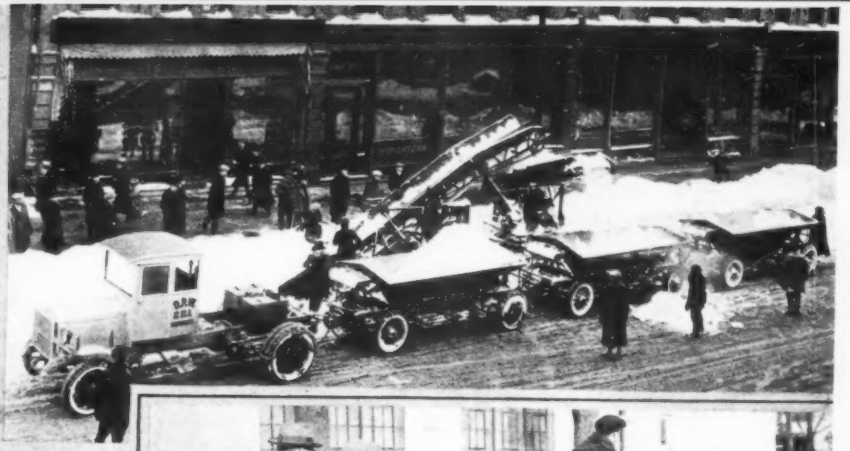
SIDE AND END VIEWS OF SECTIONS OF DETROIT RIVER TUNNEL







*Upper Left: Whitehead & Kales sidewalk sweeping machine*



*Upper Right: Milwaukee uses Highway trailers for snow.*



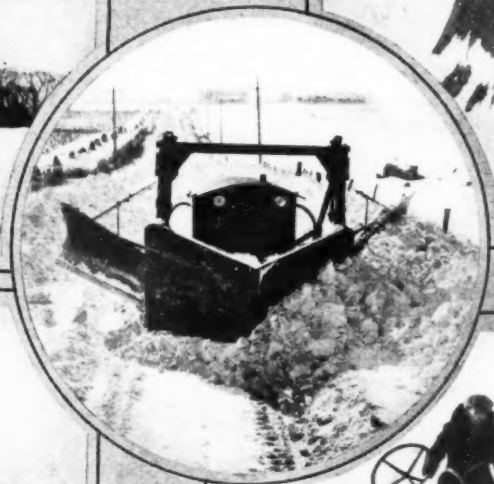
*Left: Barber-Greene loaders cut casts.*



*Above: Griford-Wood Street Ice Leveler and Caterpillar*

*Left: Cleveland Tractor and Sargent plow in the wilds of British Columbia.*

*Below: Another Cletrac working with a rotary in Michigan.*



*Circle: LaPlant-Choate and Caterpillar in Iowa*



*Left: "Cat" 2-ton and Russell Motor Patrol*

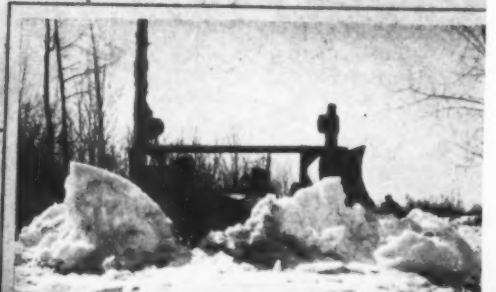


*Left: A Warco unit breaking through after a storm.*

*Below: Wausau plow hitting the drifts in Michigan.*



*Left: Rotary Snow plow "making the dust fly."*





*Joy Snow Loader picks up and loads snow economically*



*Babert Northwest machine helping New York City dig out after a snowstorm*



*Above: Allis-Chalmers Monarch 75 and Baker Snow clearing drifts.*



*Monarch 50 and Baker blade plow into Austin Western grader 12,000 feet up in Colorado.*



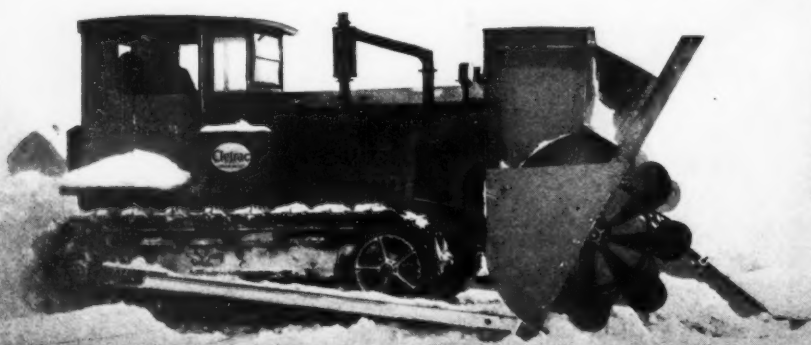
*In Circle: Universal Crane helps out in Utica*



*Above: Haus Snow Loader in operation*



*Right: A 'Cat' 20 going through some real drifts.  
Left: Snow King Widening and Loading plow Model 56.*



*Above: A Caterpillar driven Rotary strikes a 36' Oak Drift.  
Left: A rotary-equipped Cletrac.  
Right: This happens even in Pennsylvania.*







# Recent Legal Decisions

## "DOMESTIC PURPOSES" IN A WATER RATE SCHEDULE

The term "domestic" in its application to water furnished by a public utility has been enlarging as consideration for the convenience and well-being of man has increased. While primarily "domestic" relates to home life, to household or family, it has a broader significance which must be determined with reference to the relation in which it appears. The Maine Supreme Court holds, *Pejepscot Paper Co. v. Town of Lisbon*, 142 Atl. 194, that "all domestic purposes" following the enumeration of dwelling and other houses contemplates the using of water for health, comfort and sanitary conveniences in buildings other than dwellings. The fact that the building to which water is supplied is used for industrial purposes is not the criterion by which to determine whether the water supplied is used for domestic purposes. The test is an intended use which in its nature is domestic. If the water is used for a purpose common to all domestic establishments it is none the less used for domestic purposes because it is ancillary to a trade, manufacture, or business. Water supplied to a factory for the mere personal convenience of men employed in the factory is supplied for domestic purposes, and not for any trade purpose at all. The water furnished by a municipality to the restrooms of a manufacturing plant, for the personal convenience of the employees of the plant, was held to be for uses domestic in nature and properly metered and billed under the "all domestic purposes" classification of a rate schedule.

## COMPENSATION TO WATERWORKS COMPANY ON ACQUISITION OF ITS PLANT BY MUNICIPALITY

The New Jersey Court of Errors and Appeals, *Passaic Consol. Water Co. v. McCutcheon*, 144 Atl. 571, holds that Chapter 195 of the Laws of 1923, authorizing municipalities to acquire and operate privately owned water works, is insufficient to afford to a privately owned water company a full and complete method for the obtaining of just compensation for its water works, rights, franchises and property, in that it fails to provide any method of compensation for such extensions, betterments and improvements as it may be obliged to make to its property during the pendency of the condemnation proceedings to render adequate service as a public utility.

## REQUIREMENT OF PENNSYLVANIA STATUTE OF BUILDING CONTRACTOR'S BOND DOES NOT APPLY TO SEWER CONSTRUCTION CONTRACTORS

The Pennsylvania Supreme Court, *Patterson v. New Eagle Borough*, 144 Atl. 423, holds that, as neither the Act of 1917 nor its amendment of 1928, requiring boroughs to require bonds from public building contractors, requires such bonds from sewer contractors, a bond given solely for protection of the municipality by a sewer contractor can only be enforced by the borough, for its own use, although the bond mistakenly recites these statutes, and the surety was refused leave to intervene in an action by the assignee of the contractor against the municipality for a balance due to the contractor and retained by the municipality, on the

ground, *inter alia*, that there was no liability on the part of the surety to laborers and materialmen.

## MANDAMUS TO COMPEL BUILDING PERMIT FOR GARBAGE DISPOSAL PLANT IN ANOTHER MUNICIPALITY REFUSED

The New Jersey Supreme Court held, *Neptune Township v. Asbury Park*, 143 Atl. 867, that where an ordinance authorizing the construction of an incinerating plant was approved on second reading June 12, 1928, with the date for final reading and passage fixed for June 26, but nothing was shown to lead to the inference that it was read and considered on the latter date, the court would infer that the ordinance was never finally passed, and an application for a writ of certiorari to review it was premature and was denied.

At the same time, the court held, *Asbury Park v. Neptune Township*, 143 Atl. 867, that where a city's right to erect a garbage disposal plant in another municipality, a township, without the latter's consent, was not clear and free from doubt under the New Jersey Home Rule Act, a peremptory mandate would not issue to compel the township to perform an act which was at least of doubtful legal character.

## POLLUTION OF STREAM ON PRIVATE PROPERTY BY SEWAGE DISPOSAL PLANT

The New Jersey Court of Errors and Appeals, *Ennever v. Borough of Bergenfield*, 144 Atl. 809, states it to be the settled law in New Jersey that municipal corporations are not liable for negligence except under a statute imposing liability; but holds that this exception does not extend to active wrongdoing causing special damages, such, as was found by the jury under instructions of the trial court in this case, as the maintenance of a nuisance in the form of a joint sewage disposal plant and a joint sewerage system adjoining plaintiff's property. The record showed that the operation of the disposal plant caused a brook flowing through the premises to fill with sewage and filth to the special damage of the property.

## ORDINANCE FOR CONSTRUCTION OF SEWAGE TREATMENT PLANT HELD VOID FOR INDEFINITENESS BY ILLINOIS SUPREME COURT

The Illinois Supreme Court holds, *Village of Lena v. Kable*, 327 Ill. 246, 158 N. E. 409, that an ordinance for the construction of an improvement must describe the contemplated improvement with certainty. It is not necessary, however, to set forth in minute detail every particular of the improvement and every circumstance of the work, since some discretion concerning details must necessarily be left to the board of local improvements. An ordinance for the construction of a local improvement may make a certain product, substance or compound the standard of quality and fitness, and require that only material equal to it in all respects shall be used. This discretion, however, may only be exercised to permit the substitution of a particular substance or ingredient which meets the standard prescribed, but it is not broad enough to

allow the construction of a substantial part of the improvement in a manner and of materials essentially different from the specifications of the ordinance. So it was held that an ordinance for the construction of a sewage treatment and disposal plant which provided that: "The treatment plant shall consist of a septic tank of the following form, dimensions and specifications, or its equal in efficiency," was indefinite and insufficient and therefore void, since it permitted of the substitution of a treatment plant altogether different from that specified, subject only to the condition of equal efficiency. One plant may be as efficient as another, yet substantial differences between the two in cost and durability may exist. A valid ordinance being the basis of every special assessment under the Illinois Local Improvement Act of 1897, p. 101, if the ordinance is void, the county court has no power to confirm the assessment for the improvement.

**SEWER ASSESSMENT HELD INVALID AS TO  
PROPERTY RECEIVING NO BENEFIT**

The New Jersey Supreme Court, *Beattie Mfg. Co. v. Little Falls Township*, 144 Atl. 634, held that the assessment of a property for the construction of a sewer was precluded where the property was located below the level of the street, so that the sewage from buildings erected thereon would not flow into the sewer. The sewer was on the opposite side of the street from the property, so that connections were impossible or impractical, and the sewage from the lot had already been taken care of by the existing sewer, so that the property received no benefit from the sewer.

**STATUS OF WORKER ON SEWER CONTRACT UNDER  
WORKMEN'S COMPENSATION ACT**

In *Henry v. Mondillo*, Rhode Island Supreme Court, 142 Atl. 230, an action by a physician to recover from a sewer contractor, as employer, under the Workmen's Compensation Act, for services to a bricklayer injured while working on a sewer which the contractor had a contract from a city to lay, the only question was whether the bricklayer was an employee or an independent contractor. The injured person was employed by the sewer contractor to construct manholes and catchbasins on prescribed plans for a stated price and without any apparent control on the part of the contractor. He did not furnish his own helpers, nor were they under his absolute control. He worked with the contractor's servants according to his direction, upon premises not under his control, and with appliances, such as staging, rope and building materials, which he did not furnish. It was held that he was an employee, and in the circumstances the method of payment, the option as to time in doing his work, and the fact that his employer did not give him unnecessary instructions did not make him an independent contractor; and decree for the defendant was reversed.

**OBLIGATION TO KEEP BRIDGES IN REPAIR**

At common law a bridge is necessarily an integral portion of the highway or road crossing it. Where a state-aid highway was taken over by the Pennsylvania state highway department under the Sproul Act of 1911, and the bridge which it crossed, then a township bridge, was taken over with it, its status as a township bridge ceased, and thereafter the supervision of it and

the duty of keeping it in repair were transferred from the township to the state highway department. It was therefore held that no obligation thereafter resting on the township to repair the bridge, it was not liable for injuries afterwards sustained by a pedestrian from failure to properly repair the bridge. *Schlusser v. Manor Tp., Armstrong County*, 293 Pa. 315.

**ASSUMPTION OF RISK BY CITY EMPLOYEE—NECESSITY FOR NOTICE OF ACCIDENT**

The Kansas Supreme Court holds, *Davis v. City of El Dorado*, 267 Pac. 7, that a healthy, mature, able-bodied workman, employed by a city to trim trees in a park, assumes the risk of injury caused by the falling of branches which he cuts from the trees, where he is furnished with a ladder to assist him in climbing trees and a saw with which to cut off the branches, but is not furnished any other tool or implement, where no rule is prescribed for him and no instructions are given to him, and where, before he commences to work, he can see the danger from branches falling to the ground.

The Kansas statute requiring notice to the city within three months after injury is held to apply to an employee of the city who desires to recover from the city. The statute does not violate any provision of the state or Federal Constitution.

**DISCRETION UNDER STATUTE TO PAVE ONLY ONE  
SIDE OF A STREET**

The North Carolina Supreme Court holds, *Town of Waxhaw v. Seaboard Air Line R. Co.*, 142 S. E. 761, that under Comp. St. § 2707, a town, authorized, by a petition for a hard surface on the area between a highway and the sidewalk on one side and by resolution, to assess part of the cost on the owners of lots on that side, may levy an assessment for paving only one side of the street. There is nothing in the statute indicating that the phrase therein "part thereof" necessarily excludes a lateral pavement and applies only to a cross-section.

**STATUTORY REQUIREMENT TO LET PUBLIC WORK  
TO LOWEST BIDDER IS MANDATORY**

The Wisconsin Supreme Court says, *Wagner v. City of Milwaukee*, 220 N. W. 207, that "whenever a city charter requires public work to be let to the lowest bidder, it has been uniformly held that failure to call for bids in the prescribed way is fatal to the proceeding." Where a city has failed to follow the plain mandate of its charter that a contract for printing be let to the lowest bidder, it was held there was no right to expend city funds therefor unless these payments were made to the one who secured the contract for the work by submitting the lowest bid therefor.

**DISCRETION OF TOWN SUPERVISORS AS TO MAKING  
ROAD IMPROVEMENTS**

The Minnesota Supreme Court holds, *Romsdahl v. Town of Long Lake*, 220 N. W. 166, that the duties of town supervisors in the general maintenance, repair and improvement of town roads are discretionary. Where discretion has been exercised in an arbitrary and capricious manner the court may exercise control. Before a writ of mandamus will issue to compel the making of a particular road improvement by a town

board, it must be made to appear that there are not only available funds sufficient to make it, but also sufficient available funds to do whatever else may, in the reasonable judgment of the board, be needful on the other town roads.

#### WHAT CONSTITUTES AN "OILING" OF STREETS

The Iowa Supreme Court holds, *Jackson v. City of Creston*, 220 N. W. 92, that a street improvement by flushcoating with liquid reflushcoating bituminous oils, making a coating from one-quarter to one-half inch thick, together with the repair of many defects in the pavements, was not an "oiling" of the streets within the meaning of Iowa Code 1924, § 6002, providing that: "The city may oil (or choride) the streets without letting a contract therefor." Therefore, under sections 5991 and 6004, a contract by the city for such an improvement, entered into without submitting the proposal therefor to competitive bidders, was held void, precluding the assessment of the cost of the improvement against the abutting property owners. The court said: "A custom quite general in small towns of oiling unpaved streets to allay the dust has existed for years in this state. Oil thus used is put on the street by a sprinkler similar to an ordinary water sprinkler. The process is comparatively inexpensive. The very general use of oil for sprinkling unpaved streets to allay the dust has become known as oiling. In this sense the word is given its usual and ordinary meaning. 'It was this simple, inexpensive process, it was held, the Legislature had in view in section 6002.

#### REMEDY FOR OFFICIAL'S REFUSAL TO PAY INSTALLMENT DUE ON ROAD CONSTRUCTION CONTRACT

A fund was provided to build a county district road in West Virginia and placed in the hands of the sheriff. The construction of the road was contracted for, payment to be made in monthly instalments. While the work was in progress, and before the fund therefor was exhausted, the sheriff refused to pay a draft issued to the contractors as an instalment due on the work, stating that no funds would be available for that purpose for several months. The contractors then declared the contract terminated and sued the county court on a quantum meruit. The West Virginia Supreme Court of Appeals, *White v. County Court of Mingo County*, 142 S. E. 440, held that the action could not be maintained. The plaintiffs could have required the sheriff to indorse the draft when payment was refused, and from that date the draft would have drawn legal interest. His refusal to pay the draft when presented gave the contractors a right of immediate action against him.

#### COUNTY BOARD MAY ADVANCE MONEY TO STATE HIGHWAY COMMISSION FOR HIGHWAYS TO BE LOCATED IN COUNTY

The North Carolina Supreme Court holds, *Parker v. State Highway Commission*, 143 S. E. 871, that a county board of commissioners had power, under the statute, to enter into a contract by which the board advanced a large sum of money to the state highway commission in the construction of state highways located in the county and designated in the contract.

Under this contract it was agreed that the highways to be constructed should be located by the state highway commission. Such location could be made at any time prior to construction.

#### MUNICIPALITY'S RIGHT TO SELL LIGHTING PLANT

The Georgia Supreme Court holds, *Byrd v. City of Alma*, 143 S. E. 767, that if a municipality, owning an electric plant which it desires to sell, and having an opportunity to sell it on condition of complying with Georgia Acts 1925, p. 177, causes the required notice of sale to be published, and, after objections to the sale filed by protestants, an election is held and a sale authorized, and certain of the protestants file a petition to contest the election, the effect of which is to delay or prevent consummation of the sale to the contemplated purchaser, equity will entertain a petition by the city to prevent further prosecution of the so-called contest of election before the ordinary.

#### STATE HIGHWAY BOARD'S DISCRETION IN LOCATING STATE-AID ROAD

The Georgia Supreme Court holds, *Town of Camack v. State Highway Board*, 143 S. E. 367, that a court of equity will not interfere with the discretionary action of the state highway board in designating and locating a state-aid road, within the sphere of their legally delegated powers, unless such action is arbitrary, and amounts to an abuse of discretion. See also *Appleby v. Holder* (Ga.) 143 S. E. 596, to the same effect.

#### AGREEMENT AS TO COST OF ARBITRATION OF HIGHWAY CONSTRUCTION CONTRACT

An action for the balance due on a highway construction contract was by agreement of the parties referred to arbitration, the report of the arbitrators to be the final judgment of the court and binding on all parties to the action. The arbitrators awarded the plaintiff a given sum, with interest, "together with the costs of this action." It was held, *Tri-State Transp. Co. v. Stearns Bros.*, 195 N. C. 720, 143 S. E. 473, that the parties intended that the award of the arbitrators should settle all matters involved, and the arbitrators intended to include in their award as a part of the costs of the action whatever allowances should be made to the arbitrators and the fees of the stenographer. The agreement to arbitrate was broad enough to cover such allowances and fees.

#### SECOND PAVING ASSESSMENT HELD EXCESSIVE AND VOID

The North Carolina Supreme Court holds, *Flowers v. City of Charlotte*, 143 S. E. 142, that under the provisions of the Charter of the City of Charlotte in Private Laws 1911, c. 251, § 7, forbidding the assessment of any property within ten years from the last assessment in an amount exceeding 20 per cent of its assessed taxable value, a second assessment on a corner lot for pavement within ten years of the last assessment, for paving an intersecting street, in excess of 20 per cent of the assessed valuation, was void, although the second assessment was made under

Public Laws 1915, c. 56, and amendments, now C. S. § § 2703-2728.

**JURISDICTION OF ACTION AGAINST COUNTY FOR BREACH OF HIGHWAY CONSTRUCTION CONTRACT**

The South Carolina Supreme Court holds, *Ross v. Pickens County*, 143 S. E. 366, that an action against a county for breach of a highway construction contract, approved by the state highway engineer, could be maintained in the court of common pleas, the matter not being one of which the county authorities had exclusive control. The state highway commission had some authority in the matter. Federal aid was required, and the act of Congress governed in so far as such aid was concerned. The county authorities had canceled the contract, and it was held useless for the contractor to present his claim to them in the circumstances.

**STATUTE OF LIMITATIONS AFFECTING LIEN OF PAVING TAX BILLS**

Missouri Rev. St. 1919, § 8508, provides for the payment of paving tax bills in three annual payments, the lien of the bills to continue "for one year from the maturity of the tax bills last becoming due, until paid, or until the final determination of any legal proceeding to collect same." In an action on three paving tax bills instituted in March 1926, it appeared that the last bill involved became due in June 1923. The Springfield (Mo.) Court of Appeals held, *City of New Madrid v. Broughton*, 3 S. W. (2d) 1038, that there could be no recovery. The court followed the general rule that such statutes of limitation are statutes of extinguishment and not of repose. The addition of the phrase "until paid" after the limitation in the statute was held not to change the otherwise plain language of the statute.

**MARSH LANDS HELD TAXABLE FOR ROAD CONSTRUCTION**

The Louisiana Supreme Court holds, *Hulin v. Road Dist. No. 4, Parish of Vermilion*, 165 La. 443, 115 So. 650, that a police jury in including in a road district marsh lands, which would receive appreciable benefit from road construction even although the roads were laid out on high lands, did not abuse its discretion, and therefore an ad valorem tax levied on all the lands in the district did not contravene any of the provisions of the state or federal Constitutions.

**OPERATOR OF STONE CRUSHER'S RIGHT TO WORKMEN'S COMPENSATION**

The Wisconsin Supreme Court holds, *C. R. Meyer & Sons Co. v. Grady*, 194 Wis. 615, that the operator of a stone crusher furnished to a road contractor by its owners under a rental contract, who was under the control and direction of the contractor, and did work other than operating the crusher when requested by the contractor, and who was paid by and subject to discharge by the contractor, is an employee of the contractor entitled to compensation for injury, and not an independent contractor. In determining this question, the written contract between the parties, though of considerable weight as evidence, was held not conclusive, the actual relationship of the parties at the time of the injury, the surrounding facts and circumstances at the time of execution of the contract, the

purpose for which it was executed, and the construction given it by the parties themselves, being entitled to weight. It was held that a person may be an employer and liable as such for injuries to an employee under the Workmen's Compensation Act even though he does not direct the employee's work, if he possesses the power to direct it.

**EXPENSE OF CONSTRUCTION AND MAINTENANCE OF FLORIDA STATE ROADS**

The Florida Supreme Court, in an Advisory opinion to the Governor, 114 So. 850, says that the state road department is a state agency and component part of the state government. The product of its work is state property. It exercises part of the sovereign power of the state, and its activities are supported by funds created by state taxes and federal aid funds. The construction and maintenance of state roads are among the current expenses of the state, to defray which the Constitution commands the Legislature to provide for raising sufficient revenue for each fiscal year. The court advises that it is not the Governor's duty to countersign, and, in view of Florida Const. art. 9, §6, prohibiting the issuance of state bonds except to repel invasion or suppress insurrection, he should not countersign warrants on the state treasurer on an indebtedness created by a state agency in violation of this provision, such as warrants for the principal or interest on an improper emergency loan to the state road department.

**RECOVERY FOR MATERIAL USED ALTHOUGH BOARD'S RESOLUTION THEREFOR DEFECTIVE**

The Alabama Supreme Court holds, *Greeson Mfg. Co. v. County Board of Education*, 117 So. 163, that where building material was sold and used in the construction of a school building, the material being furnished at the request of the county board acting within the scope of its authority, recovery could be had therefore on proof that the sum verbally agreed upon represented a fair, reasonable market price therefor, although the matter of the contract was not embraced in any resolution of the board. The board's duty to reimburse the materialman was held to arise, not by virtue of the contract, but from "the general obligation to do justice, which binds all persons, whether natural or artificial."

**NECESSITY FOR SERVICE OF NOTICE TO CONSTRUCT SIDEWALK ON ABUTTING OWNER**

The Oklahoma Supreme Court holds, *White v. Burzan*, 267 Pac. 249, that, under Oklahoma Comp. St. 1921, sections 4628-4635, prescribing the procedure for the construction of sidewalks by a city or town, and levying special assessments upon abutting lots, and providing for the service of notice upon the owner, if he be a resident of the municipality, to construct such sidewalk within 30 days, the municipality, on his failure, being authorized to have the improvement made and charge the expense to the property, the municipality cannot construct such walk and charge the expense to the abutting owner without the adoption of the resolution declaring it necessary, provided for by section 4629, and the service of the notice on the owner provided by section 4630, the owner being the owner at the date of service of the notice. Special assessments levied without service of such notice are held invalid.